



AFMES-AFDIL's Contributions & Resources



National League Of Families of American Prisoners & Missing in Southeast Asia Meeting June 19-23, 2019

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Director, DoD DNA Operations
Armed Forces Medical Examiner System





Armed Forces DNA Identification Laboratory (AFMES-AFDIL)



- Division of the Armed Forces Medical Examiner System (AFMES)
 - Defense Health Agency (DHA)
- Established in 1990
 - Utilize DNA methods to identify the remains of US service members
- Mission Partner with the Defense POW/MIA Accounting Agency (DPAA) since 1990



DoD's Only Human Remains Testing Laboratory



American Society of Crime Laboratory Directors-Laboratory Accreditation Board (ASCLD – ISO 17025 International Certification)



Federal Bureau Of Investigation (FBI) Quality Assurance Standards



DoD DA Oversight Committee (Defense Science Board 1995)



AFMES Missions Supported By AFDIL



Present Day Accounting



Past Accounting



FRS Databasing



World Wide Support

Past Accounting
Section
45 Scientist

PAS Unit 1

PAS Unit 2

Team A
DPAA Casework

Team B
DPAA Casework

Team C
DPAA Casework

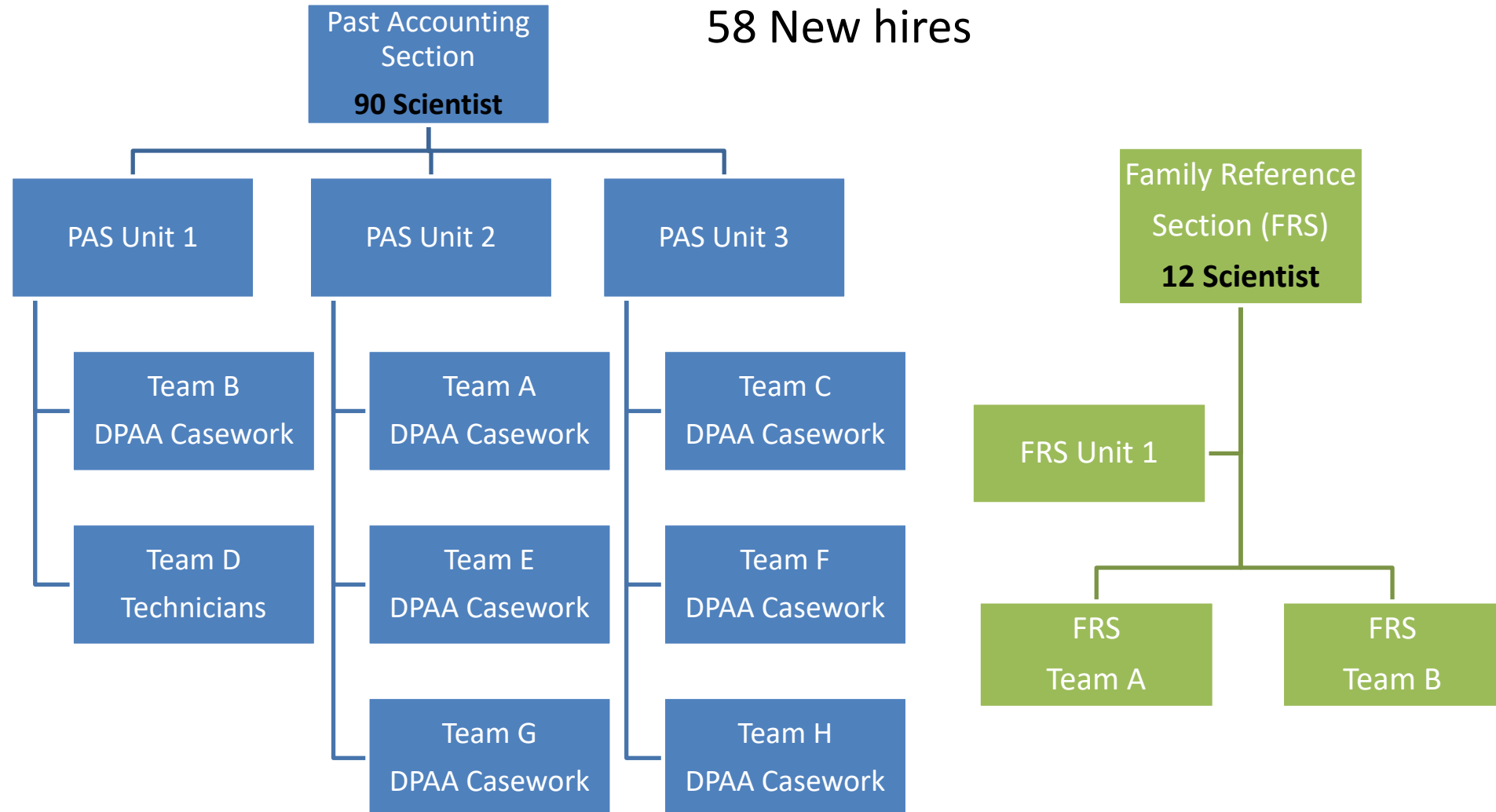
Team D
Technicians

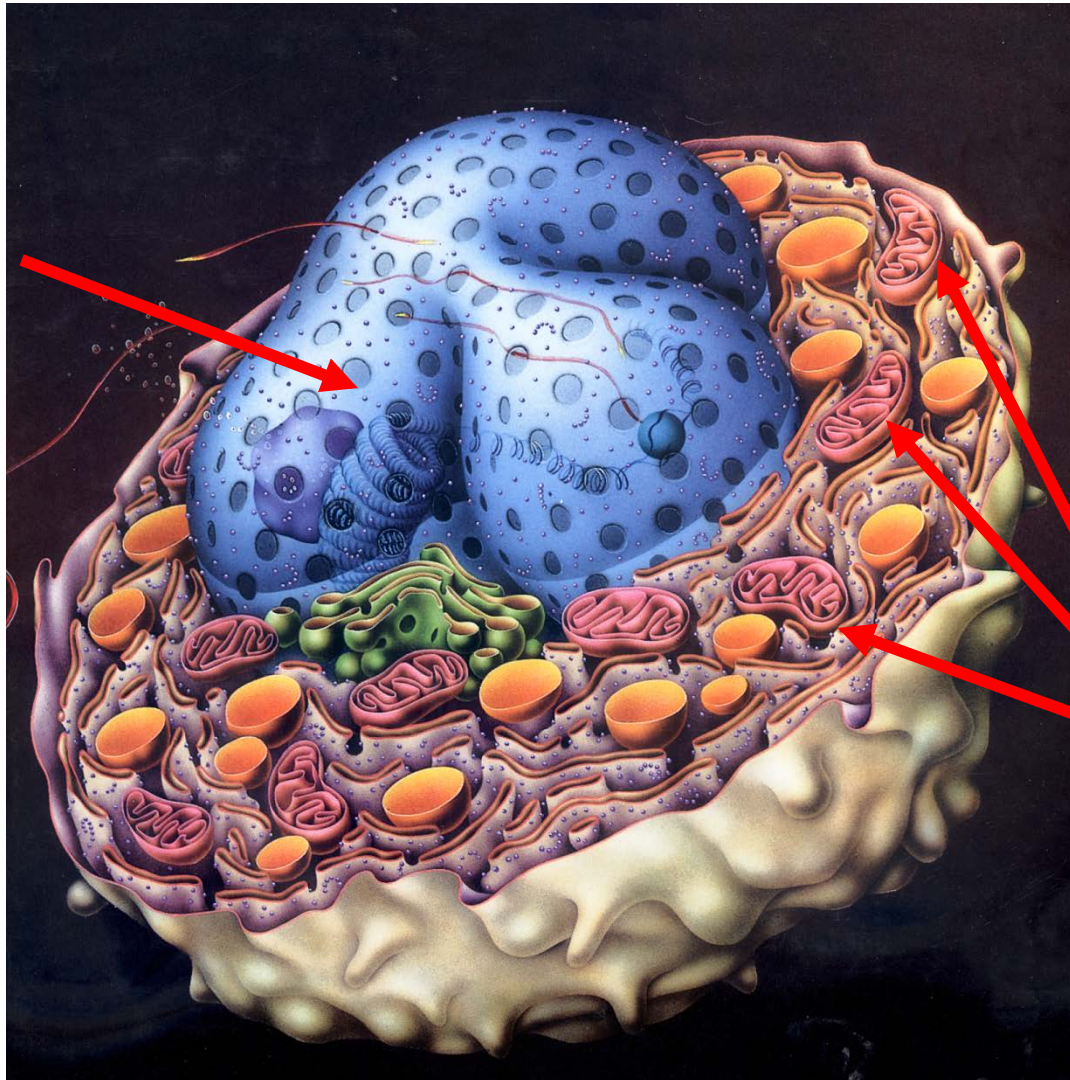
Team E
DPAA Casework

Team F
Family References

6 Teams
Casework
Family References

2 New Past Accounting Teams
New FRS section
58 New hires



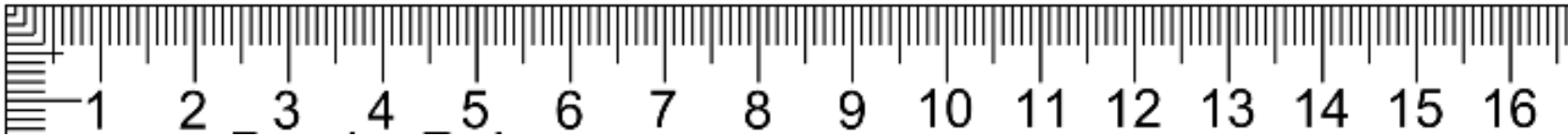


Nuclear DNA
~3.2 billion
base pairs
(bp)

**Mitochondrial
DNA**
16,549 bp



DNA Degradation: Example



inches



1 yr



2 yr



3 yr



4 yr



5 yr



6 yr

1 in = 100 base-pairs

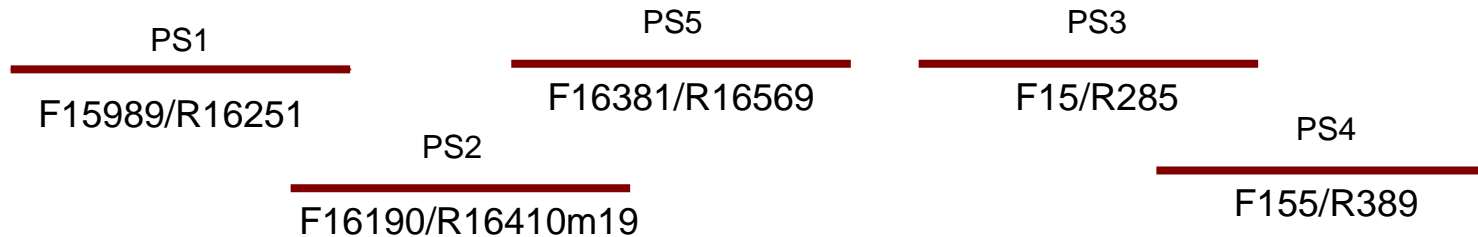
mtDNA Capabilities



Control Region



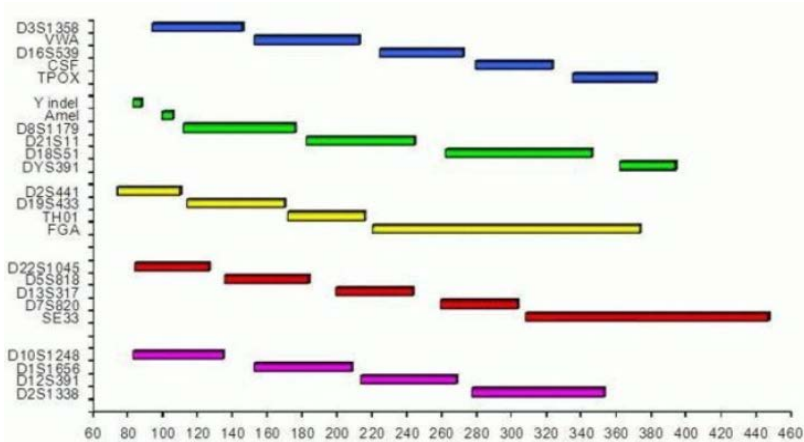
Primer sets (~200bp)



Mini-primer sets (~120bp)

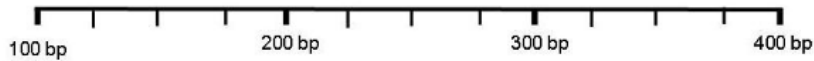


Nuclear DNA Capabilities (auSTR and YSTR)



AmpFISTR GlobalFiler

<https://www.thermofisher.com/order/catalog/product/4476135>



D13S317 D7S820

A D2S1338 D21S11

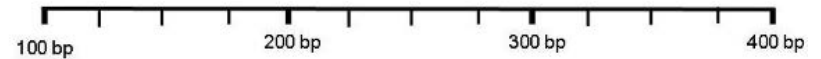
D16S539 D18S51

CSF1PO

FGA

AmpFISTR MiniFiler

<https://strbase.nist.gov/kits/MiniFiler.htm>



DYS456 DYS389I DYS390 DYS389II

DYS458 DYS19 DYS385a/b

DYS393 DYS391 DYS439 DYS635 DYS392

H4 DYS437 DYS438 DYS448

PowerPlex Fusion

<https://strbase.nist.gov/kits/Fusion.htm>



DYS456 DYS389I DYS390 DYS389II

DYS458 DYS19 DYS385a/b

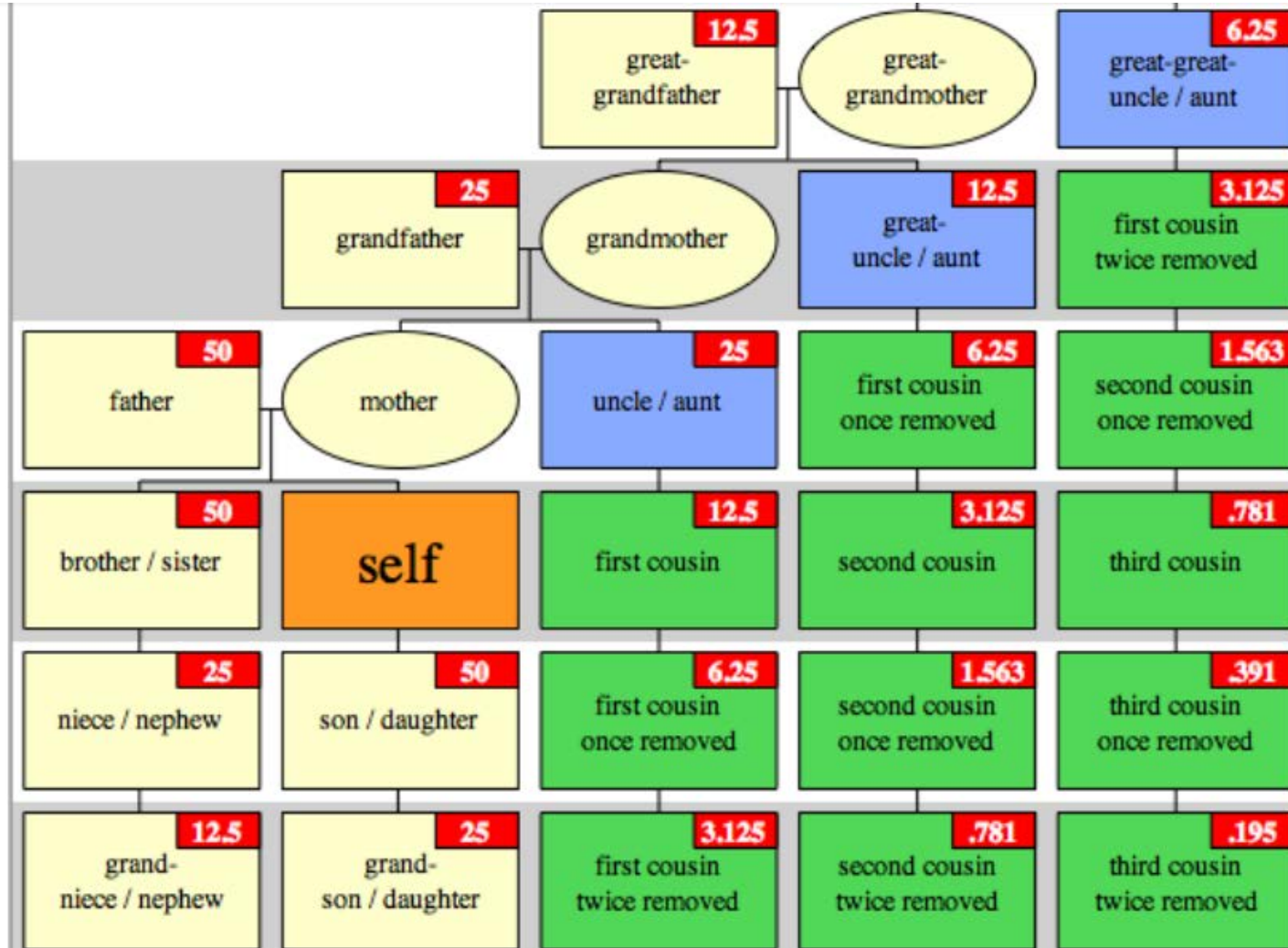
DYS393 DYS391 DYS439 DYS635 DYS392

H4 DYS437 DYS438 DYS448

AmpFISTR YFiler

<https://strbase.nist.gov/kits/YFiler.htm>

Nuclear DNA Shared Between Relatives



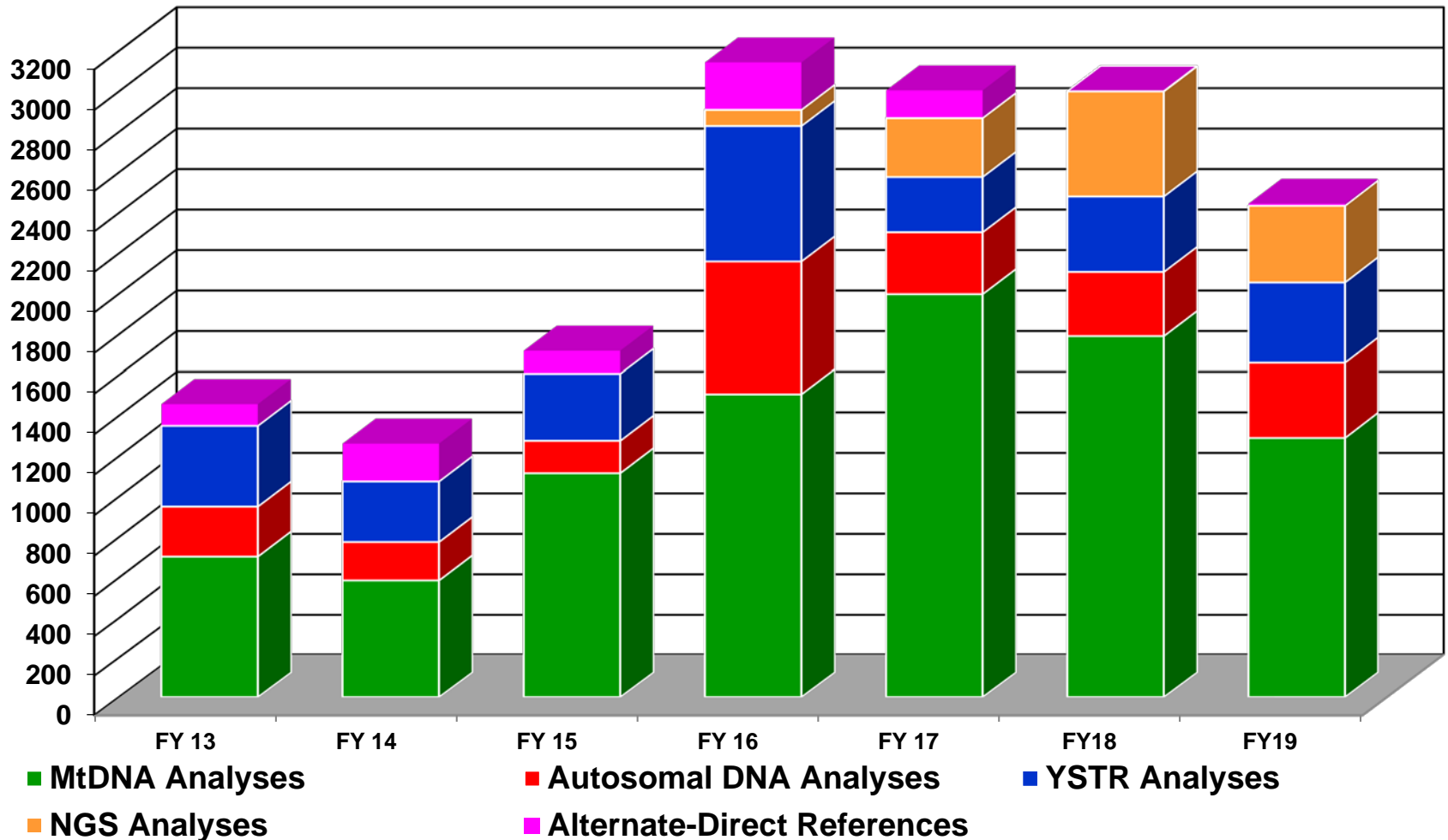
Amount of total nuclear DNA in common with ones relatives

DNA Tests Reported By AFDIL

As Of May 31st, 2019



94% Success Rate Obtaining MtDNA Sequence Data
60% Success Rate Obtaining Au-STR DNA Data
65% Success Rate Obtaining Y-STR DNA Data
62% Success Rate Obtaining NGS Data





DNA Reports

May 31st, 2019



FY	Believe to Be Reports	Addendum Reports	Foreign National	Total Reports
2012	60	103	57	220
2013	55	120	39	214
2014	75	57	51	183
2015	71	77	32	180
2016	133	65	6	204
2017	154	165	26	345
2018	189	496	34	719
2019	101	268		369

Mitogenome NGS



- Capture method was validated in December 2015 (started in June 2015)
 - 60+ page validation summary
 - 7 new SOPs and 18 new forms
- The first set of samples was processed in February 2016
 - Only the technical leader, 1 supervisor, 4 analysts and 1 technician



Research paper

Performance evaluation of a mitogenome capture and Illumina sequencing protocol using non-probative, case-type skeletal samples: Implications for the use of a positive control in a next-generation sequencing procedure

Charla Marshall^{a,b,*}, Kimberly Sturk-Andreaggi^{a,b}, Jennifer Daniels-Higginbotham^{a,b}, Robert Sean Oliver^{a,b}, Suzanne Barritt-Ross^{a,b}, Timothy P. McMahon^a



- **Overall: 1189 samples in 3 yrs**
 - 398 reportable sequence (51%)
 - World War II, Korea, Vietnam
- **303 Whole Genome FRS**
- **DNA Reports**
 - 240 DNA Comparison Reports
 - 114 First Time Named Reports
 - 126 Addendum Reports
- **Processing Capacity**
 - Increased to ~45 samples/month



Common mtDNA sequence and no auSTR or YSTR results generated:

- Sequence whole mtDNA genome
- Individuals with common mtDNA distinguishable
- Grant to expand whole mtDNA database: better statistics





Support to 200 Identifications/Year



FY	Believe to Be Reports (New IDs)	Total BTB Reports*	Number of Analysis Reported	Number of new FTEs Hired	DPAA Number of new IDs
2013	55	214	1457	0	59
2014	75	183	1301	6**	67
2015	71	180	1719	12**	80
2016	133	204	3143	6**	161
2017	154	345	3005	15** †	201
2018	189	719	3000	0	208
FYTD 2019	101	268	2445	6	

* BTB reports is total of New ID supported reports and addendum reports for additional portions

** Increase in number of analysis reported occurred in FY after individuals were hired

† Additional people increased NGS testing; increased DNA New IDs



Increase Scope and Pace



FY	DPAA requested Analysis Reported	AFMES Phased # Analysis to meet DPAA needs	Number of New Scientists Needed
2018	3000†	NA	NA
2019	5870	3400	6
2020	6470	4800	10 (16)
2021	6470	6200	10 (26)
2022	6470	6470	6 (32)
2023	6470	6470	(32)
2024	6470	6470	(32)
2025	6470	6470	(32)

† 3000 Analysis supported 200 IDs in FY17 and FY18

Why Phased: Budget Growth



Why Does DNA Take Time



- Sample quality and DNA quantity
- Authentic sequence and confidence
- **Forensic instruments and kits geared toward modern crime samples**
- Optimization of methods
- **AFMES has to create new testing method**
 - No commercial kits/have to develop
 - Science needs to catch up
- Family References

Approaching CSI Shows



Public Law 115-50
115th Congress

An Act

To establish a system for integration of Rapid DNA instruments for use by law enforcement to reduce violent crime and reduce the current DNA analysis backlog.

Be it enacted by the Senate and House of Representatives of the United States of America in Congress assembled,

SECTION 1. SHORT TITLE.

This Act may be cited as the "Rapid DNA Act of 2017".

SEC. 2. RAPID DNA INSTRUMENTS.

Aug. 18, 2017
[H.R. 510]

Rapid DNA Act
of 2017.
42 USC 13701
note.

Nov. 22, 2018, 2:27 p.m.

CAMP FIRE

By RONG-GONG LIN II

Rapid DNA analysis is being used to identify dozens of California fire victims

NEWS

State panel approves NYC's use of 'Rapid DNA' technology in disaster situations



The ANDE Rapid DNA instrument - FBI NDIS Approved

ANDE Corporation's Rapid DNA Identification System First to Receive FBI Approval Under New Standards June 2018

DNA results in under 2 hrs

RAPID Instruments



- PROS
 - Developed for Swabs
 - High Copy Samples
 - Fast
 - Booking Stations/Family assistance Centers
 - Adoptable to other samples
 - Bone, Cigarettes, tissue



- CONS
 - Modern samples only
 - Fresh Bone/buccal swabs
 - Autosomal STR based only
 - 7 samples/low throughput





Create New Method



- **No viable mtDNA, YSTR, or auSTR references available**
- Genetic Genealogy:
 - Who am I related to
 - What potential medical issues may I have
 - What is my heritage
- Ancestry.Com, 23 and Me
- Golden State Killer (April 2018)



Golden State Killer

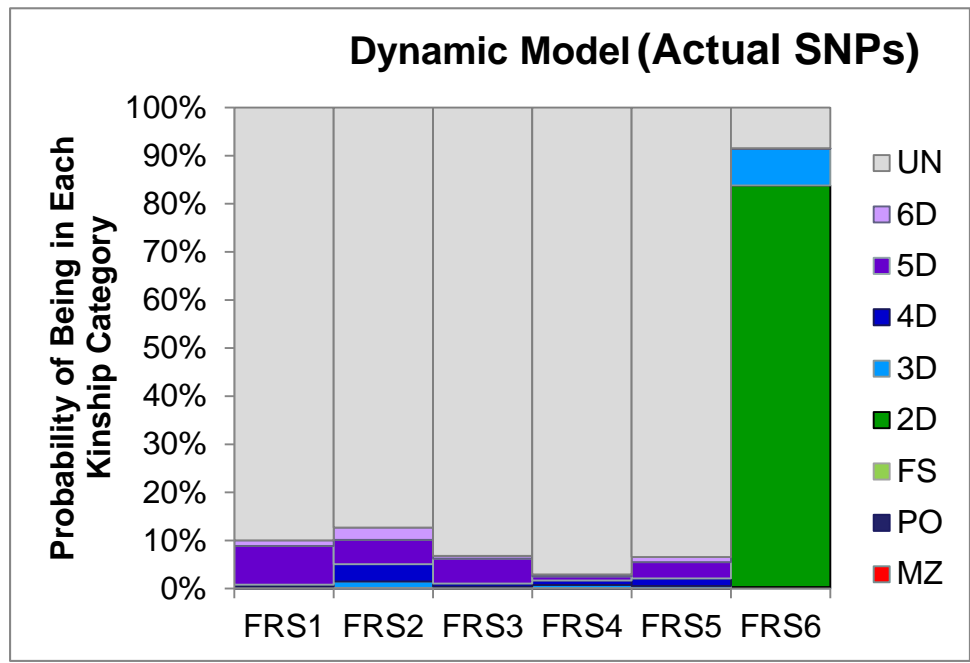


- 1975-1986: Crime spree (murders, rapes, burglaries.
- Rape case samples frozen: DNA Technology had to catch up.
- GedMatch Open Database started in 2011
 - Allows matching independent of vendor results
 - Only shows matches and not raw data
- Can this work for Past Accounting
 - Not in current commercial form
 - DNA too damaged
 - Develop method that will

- **No viable mtDNA, YSTR, or auSTR references**
 - Parabon awarded contract 2015
 - Targeted 15,000 SNPs: identify unrelated from related out to a 4th degree relative
 - Nuclear based and reference agnostic
 - Subset of the 100K typically used from the array
 - Great-Great Uncle or First Cousin 1 removed: 6.25% nuclear DNA
 - AFDIL developed SNP capture method
 - Sequencing on the MiSeq

Parabon Awarded U.S. Department of Defense (DoD) Contract to Aid Identification of Unknown Remains from Past Conflicts

1095 Out of 15000 SNPs Recovered



Related to FRS 6 (93.5%)

Related to
FRS 6



Modern Approach to DNA-Assisted Identification



- Maximize discrimination power of the mtDNA locus using mitogenome sequencing
 - Improved haplogroup/maternal ancestry prediction
- Enhanced laboratory processing using automation
 - Cheaper, better, faster
- Kinship inference using genome-wide SNP analysis
 - Improved nuclear kinship statistics

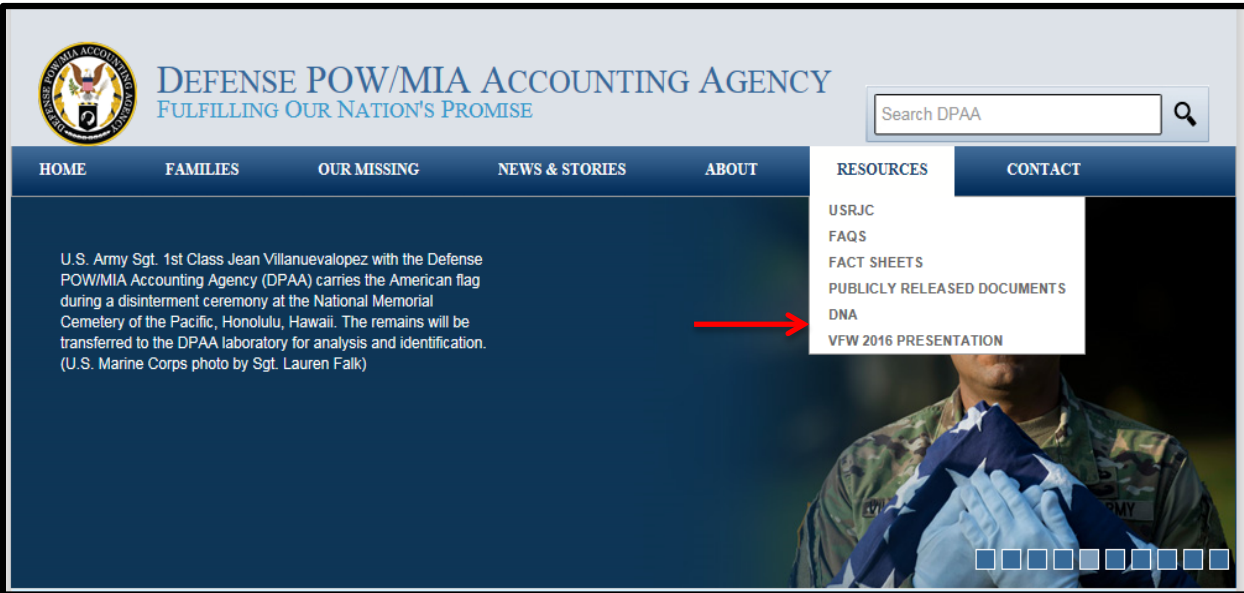
Family Reference Sample Collections



- **YOU** Are The Key To The Identification Process
- Family References Are Collected Under Informed Consent With the Donor and Can Only Be Used For Human Remains Identification
- All FRS Samples Are Treated As a Medical Specimen
- Protected Under the Health Insurance Portability and Accountability Act of 1996 (HIPAA) For Personally Identifiable Information (PII) To Release of Information
- FRS Database Information Is Restricted and Not Shared Or Uploaded To Any Outside Agency
- Release of Any HIPAA Information With PII Must Be With Consent of Donor



<http://www.dpaa.mil/>



DEFENSE POW/MIA ACCOUNTING AGENCY
FULFILLING OUR NATION'S PROMISE

Search DPAA

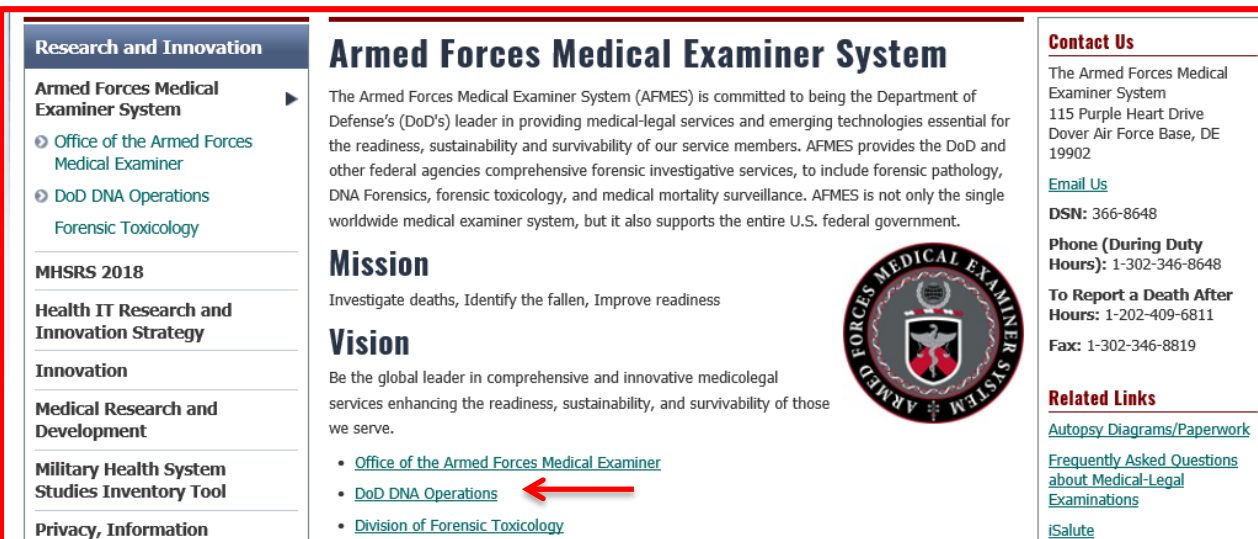
HOME FAMILIES OUR MISSING NEWS & STORIES ABOUT RESOURCES CONTACT

U.S. Army Sgt. 1st Class Jean Villanueva Lopez with the Defense POW/MIA Accounting Agency (DPAA) carries the American flag during a disinterment ceremony at the National Memorial Cemetery of the Pacific, Honolulu, Hawaii. The remains will be transferred to the DPAA laboratory for analysis and identification. (U.S. Marine Corps photo by Sgt. Lauren Falk)

RESOURCES

- USRJC
- FAQS
- FACT SHEETS
- PUBLICLY RELEASED DOCUMENTS
- DNA
- VFW 2016 PRESENTATION

<https://health.mil/afmes>



Research and Innovation

Armed Forces Medical Examiner System

- Office of the Armed Forces Medical Examiner
- DoD DNA Operations Forensic Toxicology

MHSRS 2018

Health IT Research and Innovation Strategy

Innovation

Medical Research and Development

Military Health System Studies Inventory Tool

Privacy, Information

Armed Forces Medical Examiner System

The Armed Forces Medical Examiner System (AFMES) is committed to being the Department of Defense's (DoD's) leader in providing medical-legal services and emerging technologies essential for the readiness, sustainability and survivability of our service members. AFMES provides the DoD and other federal agencies comprehensive forensic investigative services, to include forensic pathology, DNA Forensics, forensic toxicology, and medical mortality surveillance. AFMES is not only the single worldwide medical examiner system, but it also supports the entire U.S. federal government.

Mission

Investigate deaths, Identify the fallen, Improve readiness

Vision

Be the global leader in comprehensive and innovative medicolegal services enhancing the readiness, sustainability, and survivability of those we serve.

- Office of the Armed Forces Medical Examiner
- DoD DNA Operations
- Division of Forensic Toxicology

Contact Us

The Armed Forces Medical Examiner System
115 Purple Heart Drive
Dover Air Force Base, DE 19902

Email Us

DSN: 366-8648

Phone (During Duty Hours): 1-302-346-8648

To Report a Death After Hours: 1-202-409-6811

Fax: 1-302-346-8819

Related Links

- Autopsy Diagrams/Paperwork
- Frequently Asked Questions about Medical-Legal Examinations
- iSalute



Director DoD DNA Operations: Timothy.P.McMahon10.civ@mail.mil