



Faculty of Health and Medical Sciences

# FORENSIC GENETICS – ETHICAL CONSIDERATIONS

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# FORENSIC MEDICINE – COPENHAGEN - DENMARK



## DEPARTMENT

Staff	
Forensic genetics	100
Forensic chemistry	40
Forensic pathology	40
• Forensic anthropology	
• Forensic odontology	
Other	50
Total	230

## FORENSIC GENETICS

Crime cases	25,000
Reference samples	12,000
Paternity cases	1,000
Immigration cases	50



# FORENSIC GENETIC PERSPECTIVES OF MASSIVELY PARALLEL SEQUENCING



## ALSO CALLED

- SECOND GENERATION SEQUENCING
- NEXT GENERATION SEQUENCING

## MAY BE USED FOR (DONE IN COPENHAGEN)

- STRs FOR IDENTIFICATION / RELATIONSHIP TESTING
- SNPs FOR IDENTIFICATION / RELATIONSHIP TESTING
- WHOLE mt-GENOME
- SNPs FOR PHENOTYPICAL TRAITS
- SNPs FOR ANCESTRY
- GENETIC DISEASES, e.g.
  - HEART
  - PSYCHIATRIC
  - SKIN, etc.
- MICROBIAL IDENTIFICATION
- TARGETED, WHOLE EXOME, WHOLE GENOME SEQUENCING



# MPS IN COPENHAGEN



## GS JUNIOR (2009) - RETIRED



## MISEQ (2013) + FORENSEQ (2014)

- FORENSIC SNPs-STRs
- mtDNA SEQUENCING
- GENES, e.g. HEART
- mRNA/miRNA/metDNA



## ION TORRENT PGM (2013) - THREE

- HID-Ion AmpliSeq™ Identity Panel
- HID-Ion AmpliSeq™ Ancestry Panel
- LT STR SEQUENCING



## NEXTSEQ 500 (2015)

- WHOLE GENOME SEQUENCING
- WHOLE EXOME SEQUENCING
- GENES, e.g. HEART, PSYCHIATRY
- mRNA/miRNA/metDNA



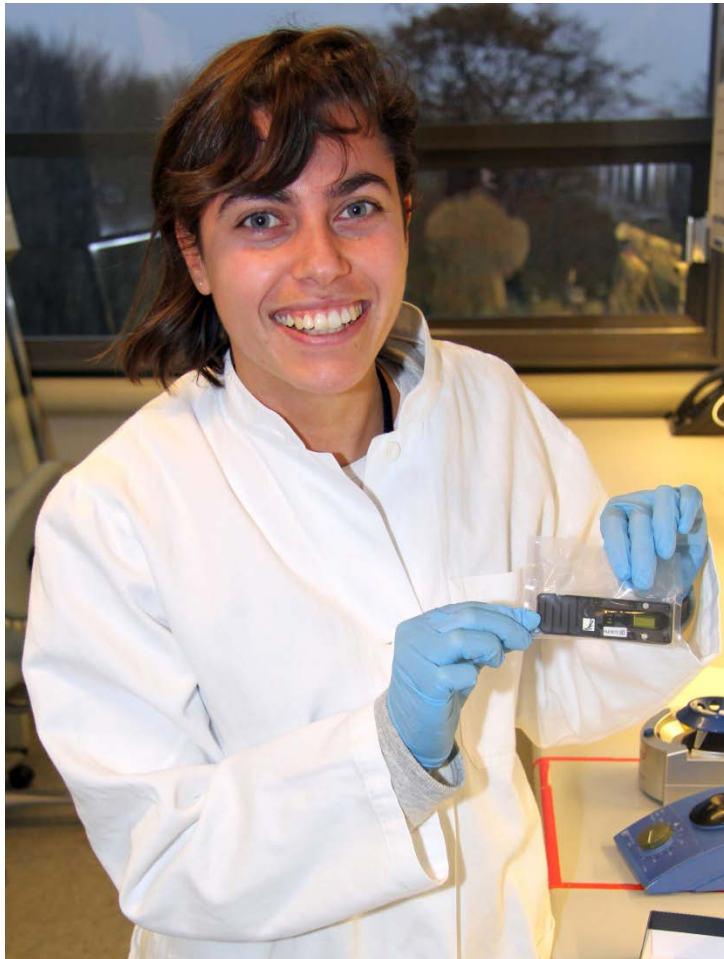
## ION S5 NGS SYSTEM (2016)

- FORENSIC GENETICS – VALIDATION



# THIRD GENERATION SEQUENCING

## MinION – Oxford NANOPORE Technologies



<https://nanoporetech.com/technology/the-minion-device-a-miniaturised-sensing-system/the-minion-device-a-miniaturised-sensing-system>



# THE DANISH WAY FORWARD



European Journal of Human Genetics (2016) 24, 817–822  
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www.nature.com/ejhg



## ARTICLE

# Genetic investigations of sudden unexpected deaths in infancy using next-generation sequencing of 100 genes associated with cardiac diseases

Christin Loeth Hertz<sup>\*,1,9</sup>, Sofie Lindgren Christiansen<sup>1,9</sup>, Maiken Kudahl Larsen<sup>2</sup>, Morten Dahl<sup>3,4</sup>, Laura Ferrero-Miliani<sup>1</sup>, Peter Ejvin Weeke<sup>5</sup>, Oluf Pedersen<sup>6</sup>, Torben Hansen<sup>6,7</sup>, Niels Grarup<sup>6</sup>, Gyda Lolk Ottesen<sup>8</sup>, Rune Frank-Hansen<sup>1</sup>, Jytte Banner<sup>8</sup> and Niels Morling<sup>1</sup>

Forensic Science International: Genetics 24 (2016) 60–64



ELSEVIER

Contents lists available at ScienceDirect

Forensic Science International: Genetics

journal homepage: [www.elsevier.com/locate/fsig](http://www.elsevier.com/locate/fsig)



Research paper

## Frequencies of HID-ion ampliseq ancestry panel markers among greenlanders

Gonçalo Espregueira Themudo<sup>\*</sup>, Helle Smidt Mogensen, Claus Børsting, Niels Morling

Section of Forensic Genetics, Department of Forensic Medicine, Faculty of Health and Medical Sciences, University of Copenhagen, Copenhagen, Denmark





## Molecular Genetics & Genomic Medicine

[Open Access](#)

### ORIGINAL ARTICLE

## Importance of nonsynonymous *OCA2* variants in human eye color prediction

Jeppe D. Andersen<sup>1</sup>, Carlotta Pietroni<sup>1</sup>, Peter Johansen<sup>1</sup>, Mikkel M. Andersen<sup>2</sup>, Vania Pereira<sup>1</sup>, Claus Børsting<sup>1</sup> & Niels Morling<sup>1</sup>

<sup>1</sup>Section of Forensic Genetics, Department of Forensic Medicine, Faculty of Health and Medical Sciences, University of Copenhagen, DK-2100 Copenhagen, Denmark

<sup>2</sup>Department of Mathematical Sciences, Aalborg University, DK-9100 Aalborg, Denmark

## ELECTROPHORESIS

2822

Electrophoresis 2016, 37, 2822–2831

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Copenhagen, Copenhagen,  
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### Research Article

## ISO 17025 validation of a next-generation sequencing assay for relationship testing

The HID-Ion AmpliSeq™ Identity Panel is a next-generation sequencing assay with 90 autosomal and 34 Y-chromosome SNPs that are amplified in one PCR step and subsequently sequenced using the Ion Personal Genome Machine (Ion PGM™) System. This assay was validated for relationship testing in our ISO 17025 accredited laboratory in 2015. Here, the essential parts of the validation report submitted to the Danish Accreditation





# HEALTH RESEARCH ETHICS COMMITTEE



**SINCE 1980, DENMARK HAS A HEALTH RESEARCH ETHICS  
COMMITTEE SYSTEM**

**IT CONSISTS OF A NATIONAL COMMITTEE AND  
11 REGIONAL COMMITTEES**

**[HTTP://WWW.DNVK.DK/ENGLISH.ASPX](http://www.dnvk.dk/english.aspx)**



# HEALTH RESEARCH ETHICS COMMITTEE



**REGULATED BY LAW IN 1992**

**HALF OF THE REGIONAL COMMITTEE MEMBERS ARE LAY  
MEN APPOINTED BY THE POLITICAL SYSTEM**

**THE OTHER HALF ARE MEDICAL PROFESSIONALS AND  
ACTIVE RESEARCHERS**

**ALL RESEARCH PROJECTS IN DENMARK INVOLVING  
HUMAN BEINGS OR ANY KIND OF HUMAN TISSUE, CELLS  
ETC., MUST HAVE PERMISSION FROM A REGIONAL  
ETHICS COMMITTEE**

**FORENSIC MEDICINE: FROM THE NATIONAL COMMITTEE**



# COMPREHENSIVE SURVEYS OF INDIVIDUAL GENOMES



## NEXT GENERATION SEQUENCING

WGS – WHOLE GENOME SEQUENCING – CAUTION ON ETHICS

WES – WHOLE EXOME SEQUENCING – CAUTION ON ETHICS

TOTAL RNA SEQUENCING – CAUTION ON ETHICS

TARGETED DNA SEQUENCING – NORMAL PROCEDURES

## GWAS –GENOME WIDE ASSOCIATION STUDIES

- 'FREQUENT' GENETIC MARKERS – NORMAL PROCEDURES

- 'RARE' GENETIC MARKERS – CAUTION ON ETHICS

## EPIGENETICS

- FEW MARKERS: NORMAL PROCEDURES

- MANY MARKERS: CAUTION ON ETHICS



# HEALTH RESEARCH ETHICS COMMITTEE



EXEMPTION FROM THE REQUIREMENT FOR CONSENT

POSSIBLE IN CERTAIN SITUATIONS

THE PRACTICAL IMPLEMENTATION IS UNCLEAR

YOUNG INDIVIDUALS / MINORS

- VERY CAUTIOUS





# HEALTH RESEARCH ETHICS COMMITTEE



## FEED BACK TO THE PATIENTS/VOLUNTEERS?

- PROBABILITY OF GENETIC DISPOSITION
- DISEASE PREVENTION
- TREATMENT
- IMPORTANCE

## ACCIDENTIAL FINDINGS

### FEED BACK IF

- PENETRANCE IS HIGH
- SEVERE DISEASE
- TREATMENT POSSIBLE



# GENETIC COUNSELLING



MUST BE AVAILABLE

VARIOUS WAYS



# FAMILY SEARCH IN DATA BASES



## SEARCH IN

- NON-CRIME CASES, e.g. DISASTERS
- CRIME CASES

## NO MATCH IN THE CRIME DNA DATABASE

- SEARCH FOR HIGH DEGREE OF SHARING OF DNA BETWEEN THE PROFILE OF A STAIN AND INDIVIDUAL(S) IN THE DATABASE
- COULD IT BE DUE TO A CLOSE RELATIVE BEING THE DONOR OF THE DNA (PERPETRATOR)?

# CLINICAL AND RESEARCH DATA BASES



- CAN CLINICAL DATA BE USED IN CRIME INVESTIGATIONS?
- CAN RESEARCH DATA BE USED IN CRIME INVESTIGATIONS?



# ANCESTRY INFORMATIVE MARKERS (AIMs)



- SINGLE NUCLEOTIDE POLYMORPHISMS (SNPs)
- LINEAGE MARKERS (HAPLOGROUPS OF mtDNA AND Y-STR)
- INDELS (INSERTION / DELETIONS)
- SEVERAL HUNDREDS MARKERS ANALYSED
- CONTINENTAL RESOLUTION ESTABLISHED  
(EAST ASIA – EUROPE – AFRICA – OCEANIA)
- FINER RESOLUTION EMERGING

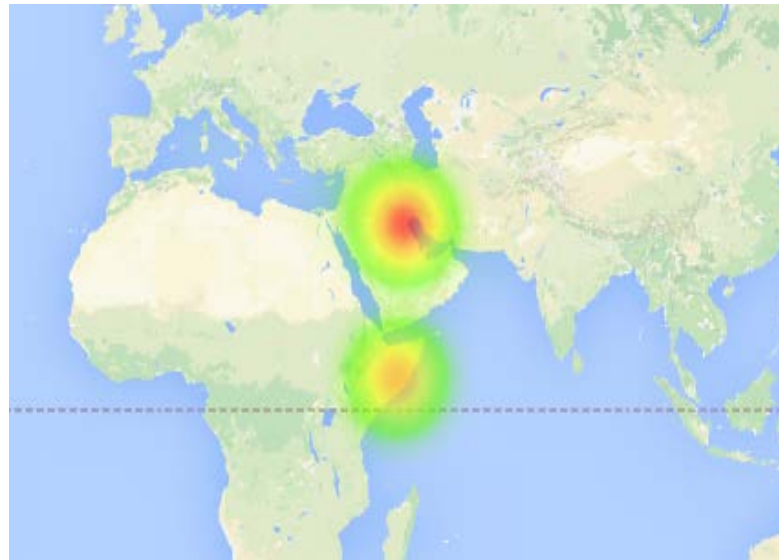
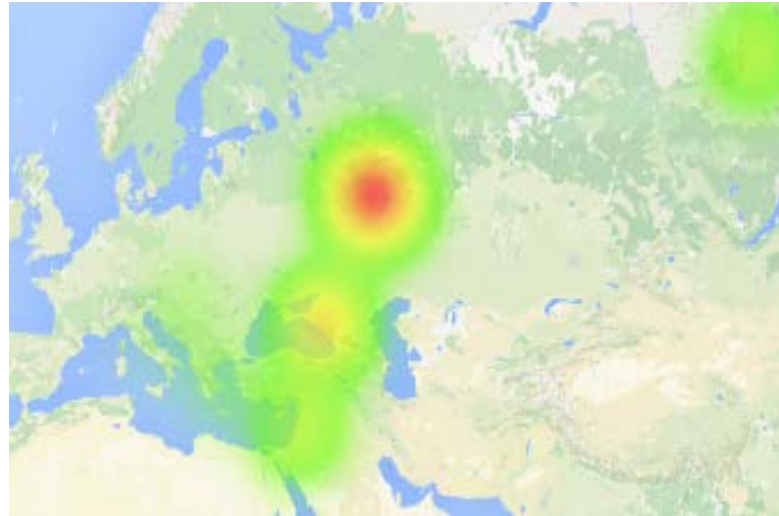
## Ancestry Analysis in the 11-M Madrid Bomb Attack Investigation

**Christopher Phillips<sup>1,2\*</sup>, Lourdes Prieto<sup>3</sup>, Manuel Fondevila<sup>1</sup>, Antonio Salas<sup>1</sup>, Antonio Gómez-Tato<sup>4</sup>, José Álvarez-Dios<sup>4</sup>, Antonio Alonso<sup>5</sup>, Alejandro Blanco-Verea<sup>1</sup>, María Brión<sup>2</sup>, Marta Montesino<sup>3</sup>, Ángel Carracedo<sup>1,2</sup>, María Victoria Lareu<sup>1</sup>**

<sup>1</sup> Forensic Genetics Unit, Institute of Legal Medicine, University of Santiago de Compostela, Santiago de Compostela, Galicia, Spain, <sup>2</sup> Genomic Medicine Group, CIBERER, University of Santiago de Compostela, Santiago de Compostela, Galicia, Spain, <sup>3</sup> University Institute of Research Police Sciences (IUICP), DNA Laboratory, Comisaría general de Policía Científica, Madrid, Spain, <sup>4</sup> Faculty of Mathematics, University of Santiago de Compostela, Santiago de Compostela, Galicia, Spain, <sup>5</sup> Instituto Nacional de Toxicología y Ciencias Forenses, Delegación de Madrid, Spain



# ANCESTRY BY SNP TYPING



# ANCESTRY, PHYSICAL TRAITS, AND SNPs



FREDERIK



ILLUMINA

Phenotype Prediction

(Sample)  
1\_FTP  
5.0 - Copenhagen A51KG

HAIR COLOR RESULTS

0.27

Brown

0.01

Red

0.04

Black

0.69

Blond

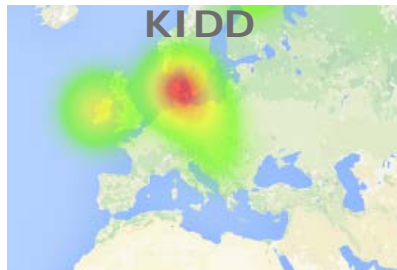
EYE COLOR RESULTS

0.04 Intermediate

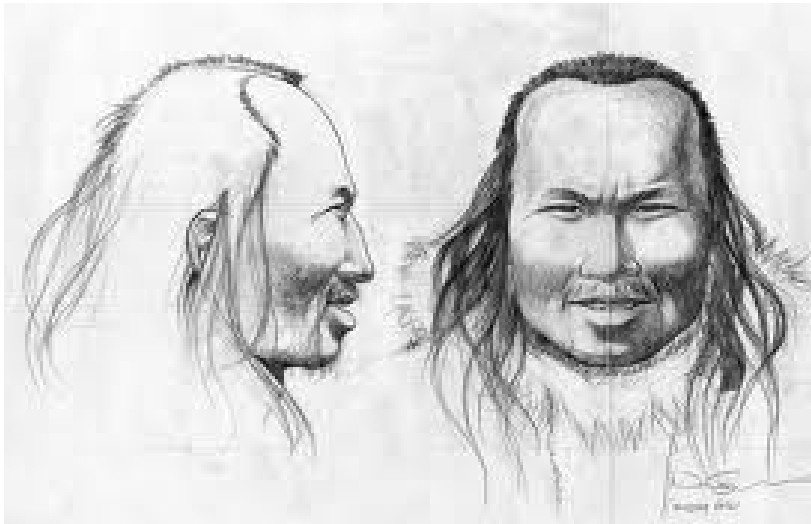
0.02 Brown

0.94 Blue

ANCESTRY RESULTS



# GREENLANDERS



Rasmussen et al. Nature 2010; 463: 757-62.





# GREENLANDERS - ANCESTRY



SCRUTINIZE DATA FROM CLINICAL INVESTIGATIONS OF  
GREENLANDERS

WHOLE GENOME SEQUENCING OF INUIT

A PhD STUDENT FROM COPENHAGEN IS NOW AT YALE  
UNIVERSITY WITH KENN KID AND HIS GROUP

FOCUS ON GREENLANDERS AND CLOSELY RELATED  
POPULATIONS, i.e.

ASIAN AND NORTH AMERICAN POPULATIONS



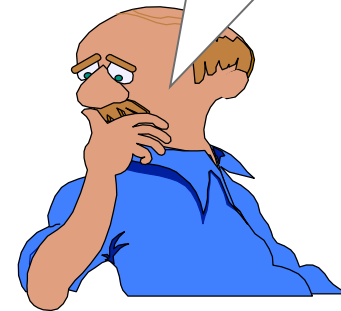
# NEW DNA SEQUENCING METHODS IN FORENSIC GENETICS



WHAT ARE WE DOING?

- TECHNIQUES
- ETHICS

*Be careful with  
new technologies  
in forensic genetics*



## WHAT DO WE WANT?



*ONE OF 120 INDIVIDUALS HAS  
AN IDENTICAL TWIN AT BIRTH  
WITH SIMILAR DNA*

*MEN HAVE IN AVERAGE AT  
LEAST ONE MALE RELATIVE  
WITH SIMILAR Y-  
CHROMOSOME DNA*

*RISK OF ERRORS, ETC.?*

*ARE FORENSIC GENETICISTS  
AFRAID OF DISCUSSING THESE  
KINDS OF FACTS?*

