



The role of DNA in Kinship Testing



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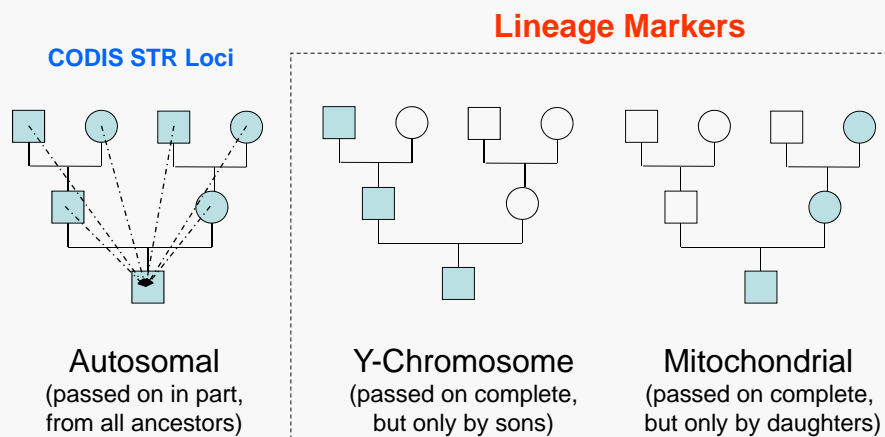
Outline

- Kinship Testing
- Kinship examples
- Likelihood ratios
- Future plans

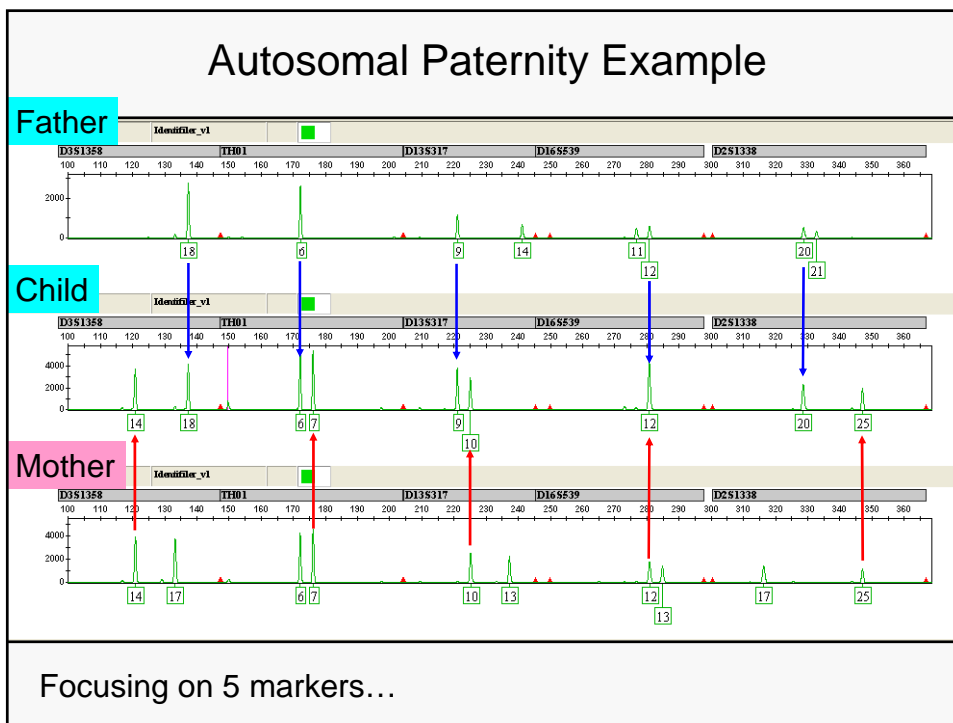
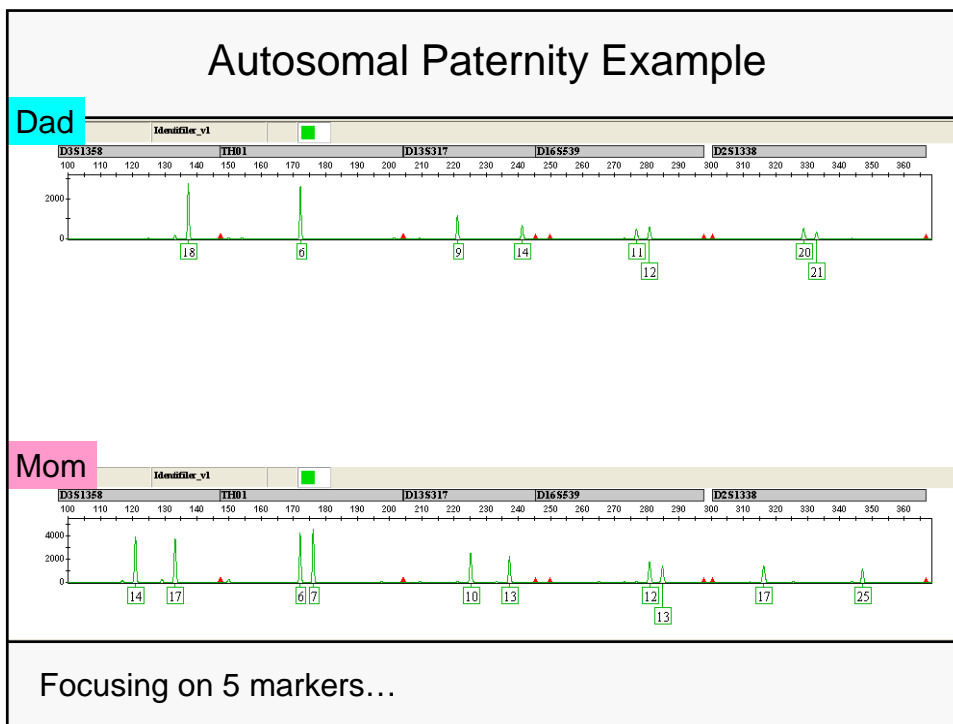
Kinship Testing

- DNA profiles can be used to evaluate the probability of a specific kinship relationship
- As a familial relationship becomes more distant the ability of DNA to confirm the likelihood of that relationship decreases
 - Parent-offspring
 - Siblings
 - Half siblings | niece/nephew | cousins

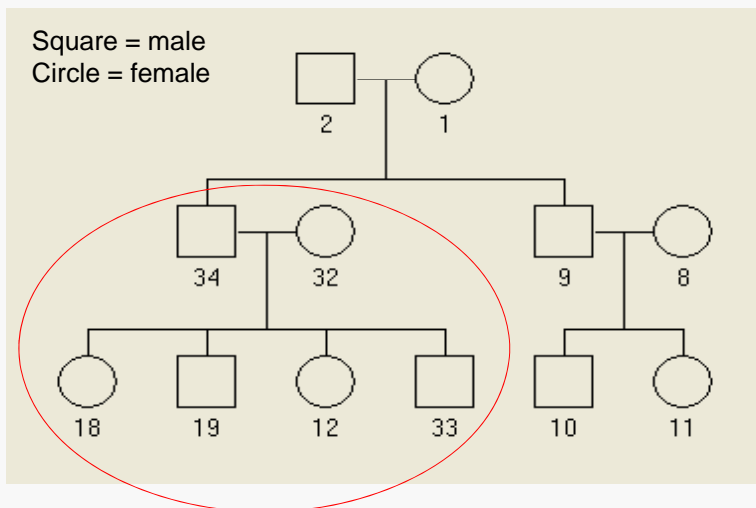
Different Inheritance Patterns



Butler, J.M. (2005) *Forensic DNA Typing, 2nd Edition*, Figure 9.1, ©Elsevier Science/Academic Press




Example Family Pedigree



Examine Basic Allele Sharing

Marker	Father	Mother
1 CSF1PO	10 10	10 12
2 TPOX	8 8	8 10
3 TH01	6 6	6 9
4 vWA	17 18	17 20
5 D16S539	11 13	8 9
6 D7S820	9 9	8 12
7 D13S317	11 14	8 12
8 D5S818	12 13	11 13
9 FGA	21 22	21 25
10 D8S1179	12 14	13 14
11 D18S51	14 16	14 17
12 D21S11	28 30	31 32.2
13 D3S1358	16 17	17 17
14 D2S1338	22 23	23 25
15 D19S433	12 14	14 14



Marker	Father	Child	Mother
1 CSF1PO	10 10	10 10	10 12
2 TPOX	8 8	8 8	8 10
3 TH01	6 6	6 6	6 9
4 vWA	17 18	17 17	17 20
5 D16S539	11 13	9 13	8 9
6 D7S820	9 9	8 9	8 12
7 D13S317	11 14	8 14	8 12
8 D5S818	12 13	11 13	11 13
9 FGA	21 22	21 25	21 25
10 D8S1179	12 14	14 14	13 14
11 D18S51	14 16	14 17	14 17
12 D21S11	28 30	28 31	31 32.2
13 D3S1358	16 17	17 17	17 17
14 D2S1338	22 23	23 23	23 25
15 D19S433	12 14	12 14	14 14

The child inherits an allele from each parent

Siblings & Avuncular

Marker	Brother		Sister	
1 CSF1PO	10	10	10	12
2 TPOX	8	8	8	10
3 TH01	6	6	6	9
4 vWA	17	17	17	20
5 D16S539	9	13	9	11
6 D7S820	8	9	9	12
7 D13S317	8	14	11	12
8 D5S818	11	13	11	12
9 FGA	21	25	21	25
10 D8S1179	14	14	13	14
11 D18S51	14	17	14	14
12 D21S11	28	31	30	32
13 D3S1358	17	17	16	17
14 D2S1338	23	23	23	25
15 D19S433	12	14	14	14

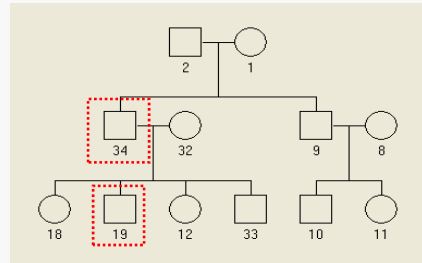
Marker	Uncle		Nephew	
1 CSF1PO	10	10	11	12
2 TPOX	8	8	8	10
3 TH01	6	6	6	9.3
4 vWA	17	18	16	17
5 D16S539	11	13	11	13
6 D7S820	9	9	9	11
7 D13S317	11	14	11	12
8 D5S818	12	13	12	12
9 FGA	21	22	20	24
10 D8S1179	12	14	10	13
11 D18S51	14	16	13	13
12 D21S11	28	30	27	31
13 D3S1358	16	17	16	18
14 D2S1338	22	23	18	22
15 D19S433	12	14	14	14

Likelihood Ratio

- Examining or counting shared alleles is qualitative
- Likelihood ratio can be used to help quantify the information

$$LR = \frac{\text{Probability of the evidence (genotypes) given a particular hypothesis}}{\text{Probability of the evidence (genotypes) given an alternative hypothesis}}$$

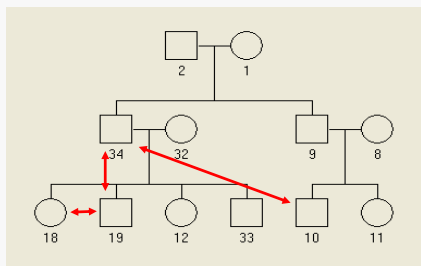
Posing a Hypothesis



- Basic equations for calculating LR are known
- Available in the literature and in commercial software
- Requirements:
 - **Genotypes** of individuals being tested
 - **Allele frequencies** for the loci involved in the testing
 - **Two Hypotheses!**

$$LR = \frac{\text{Prob. of observing the genotypes for 19 and 34 given that they are parent-offspring}}{\text{Prob. of observing the genotypes for 19 and 34 given that they are unrelated}}$$

Likelihood Ratios with 15 Loci

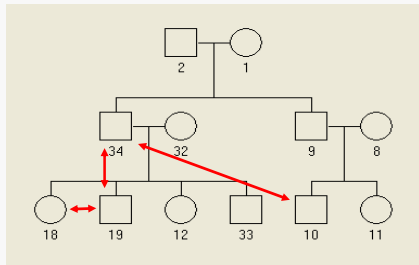


Comparison	LR for 34 & 19	LR for 18 & 19	LR for 34 & 10
Parent-Child	1.28E+06		
Full Siblings		2.76E+07	
Half Siblings			
Cousins			
Uncle-Nephew			6.65E-01
Grandparent-Grandchild			

Parent/Child Full Sibs Uncle/Nephew

LR calculations were performed with GeneMarker HIDv1.90

Likelihood Ratios with 15 Loci



Comparison	LR for 34 & 19	LR for 18 & 19	LR for 34 & 10
Parent-Child	1.28E+06	9.08E+05	0.00E+00
Full Siblings	3.22E+04	2.76E+07	6.07E-03
Half Siblings	7.38E+03	4.89E+04	6.65E-01
Cousins	1.95E+02	8.96E+02	1.52E+00
Uncle-Nephew	7.38E+03	4.89E+04	6.65E-01
Grandparent-Grandchild	7.38E+03	4.89E+04	6.65E-01
	Parent/ Child	Full Sibs	Uncle/ Nephew

LR calculations were performed with GeneMarker HIDv1.90

Allele Sharing Probabilities

Relationship	0 alleles	1 alleles	2 alleles
Parent-child	0	1	0
Full siblings	1/4	1/2	1/4
Half siblings	1/2	1/2	0
Cousins	3/4	1/4	0
Uncle-nephew	1/2	1/2	0
Grandparent-grandchild	1/2	1/2	0

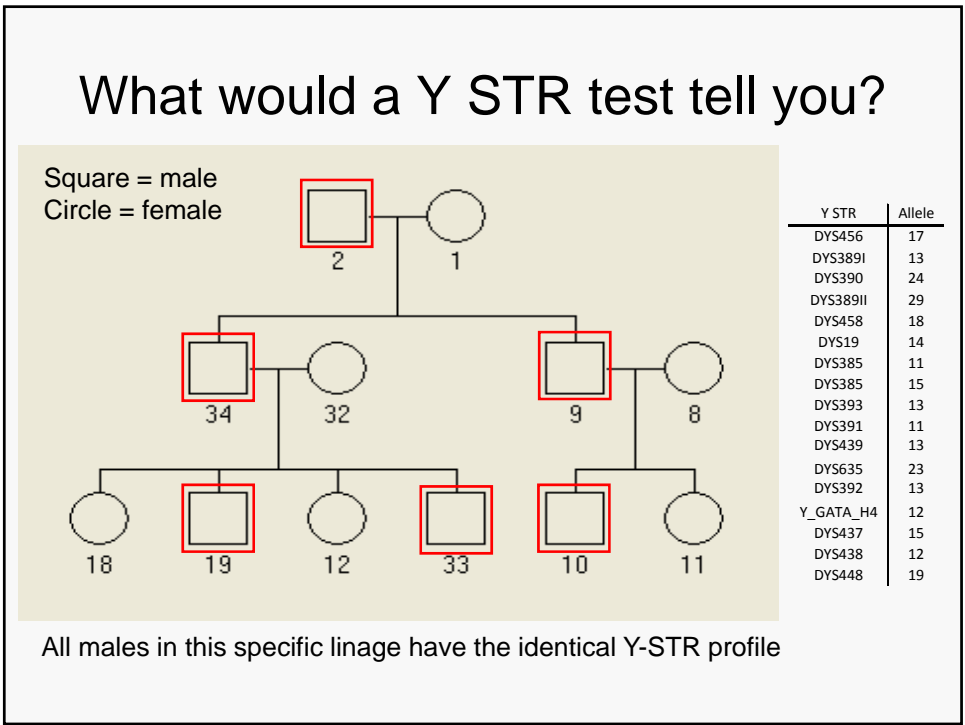
Statement about the equivalent (by LR) relationships....

Benefit of Additional Loci Likelihood Ratios with 40 Loci

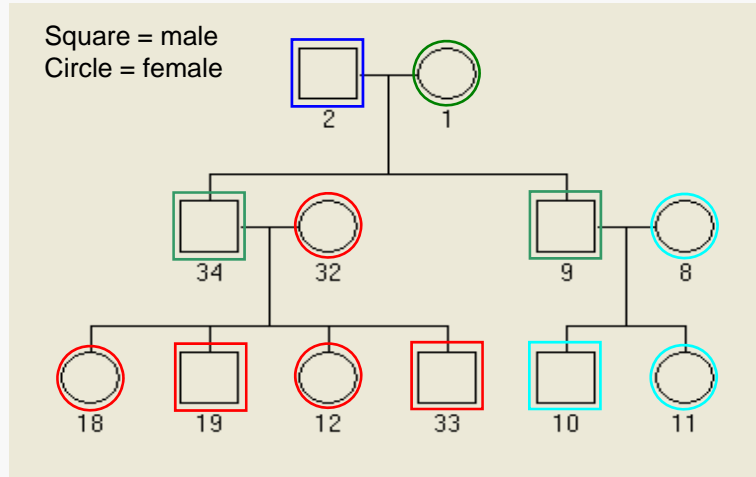
Comparison	15	40	15	40	15	40
	LR for 34 & 19	LR for 34 & 19	LR for 18 & 19	LR for 18 & 19	LR for 34 & 10	LR for 34 & 10
Parent-Child	1.28E+06	6.68E+16	9.08E+05	0.00E+00	0.00E+00	0.00E+00
Full Siblings	3.22E+04	5.73E+12	2.76E+07	1.57E+19	6.07E-03	3.30E+03
Half Siblings	7.38E+03	8.63E+11	4.89E+04	4.99E+12	6.65E-01	8.98E+05
Cousins	1.95E+02	1.32E+08	8.96E+02	1.05E+09	1.52E+00	2.17E+04
Uncle-Nephew	7.38E+03	8.63E+11	4.89E+04	4.99E+12	6.65E-01	8.98E+05
Grandparent-Grandchild	7.38E+03	8.63E+11	4.89E+04	4.99E+12	6.65E-01	8.98E+05

} Parent/
Child
} Full
Sibs
} Uncle/
Nephew

LR calculations were performed with GeneMarker HIDv1.90



What would Mitochondrial sequencing tell you?





Extended Family Samples

- 6 sets of family samples (3 - 4 generations)
- N = 163 (total samples)
- Loci examined
 - 40 autosomal loci (13 CODIS + 2, 25 NIST loci)
 - 17 Y chromosomal loci (Yfiler Kit loci)
 - 15 X STRs (AFDIL collaboration)
 - Mitochondrial control region (to be typed)
- These samples will be used to illustrate the value (or limitations) of additional marker systems

Conclusions

- It is important to identify specific kinship questions
 - Not just ‘are these people related?’
- The appropriate allele frequencies databases must exist for the loci tested
- Additional loci can help...sometimes

New Personnel

- **Ms. Erica Butts** started at NIST on August 17, 2009
 - Masters in Forensic Molecular Biology from GWU in 2008
 - Worked at Fairfax Identity Lab 2009
 - Expertise
 - STR typing, paternity testing, qPCR, DNA extraction
 - Assisted in set up of our DNA biometrics laboratory
 - Characterizing swabs and conducting stability studies
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- **Dr. Kristen E. Lewis** (Awarded NRC postdoctoral fellow)
 - University of Washington - PhD Thesis: ‘Genomic Approaches to Forensic DNA Analysis’
 - Proposal: ‘A Standardized Approach to Relatedness Testing Using Forensic DNA Typing Methods’
 - Starting her fellowship at NIST December 21, 2009
 - Will be working with kinship testing software evaluation, analysis of extended family samples, and theoretical simulations to determine the utility of kinship testing (application and limitations)
 - Prepare training materials on kinship testing (to be made freely available on STRbase)
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Erica Butts MFS

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