Handout 2-1: A Bad Week for Fishing

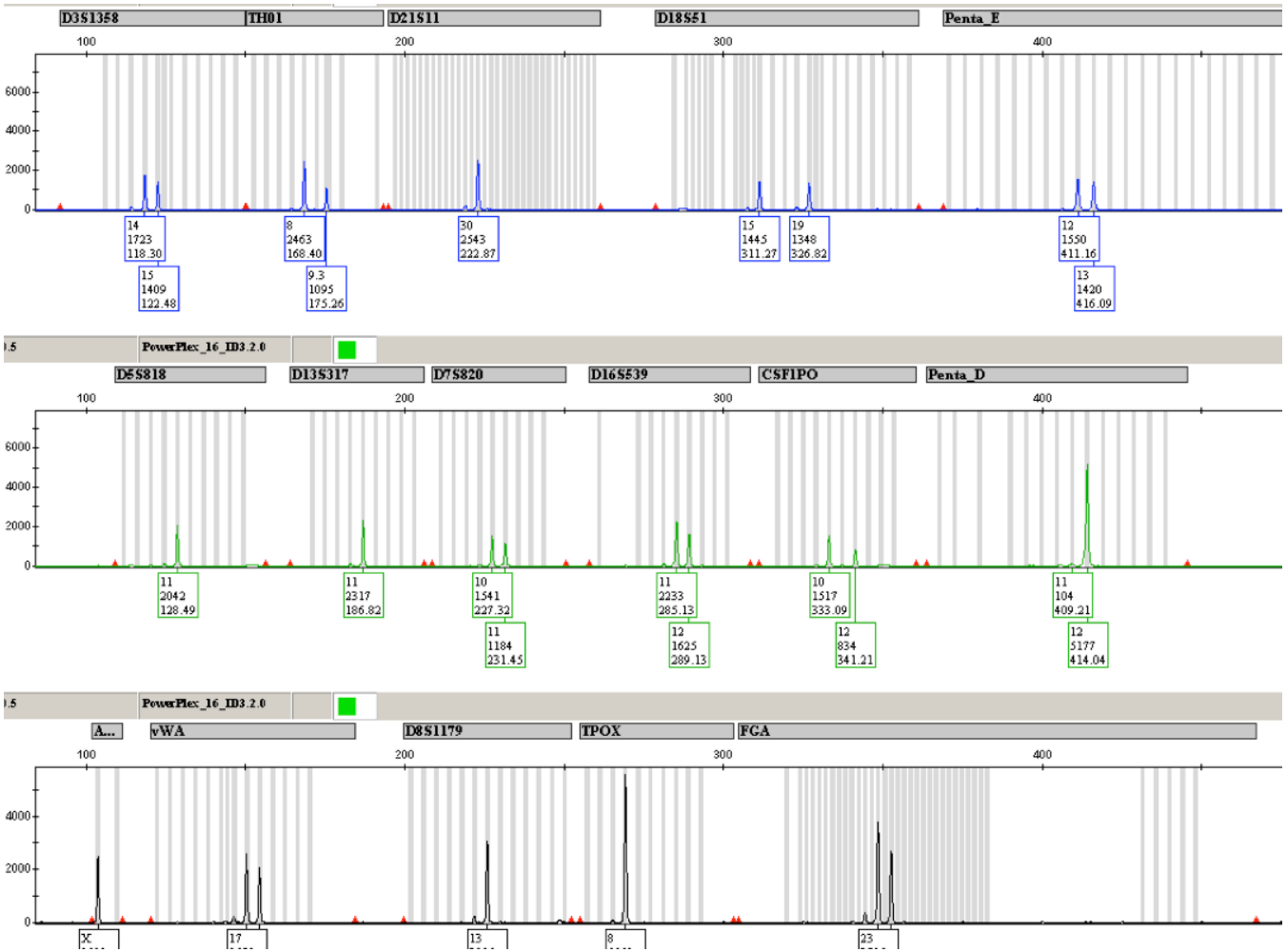
August 29, 2010: Five friends from the Bahamas suddenly found a day of fishing from their 20-foot boat plagued by engine trouble. Stalled not far from the coast of Jaws Beach – where a sequel to the movie Jaws was filmed in 1987 – two of the men decided to swim ashore instead awaiting rescue. But when rescuers finally reached the marooned boat, the two fishermen who had swum for shore were nowhere to be found. Did they both drown? Odd, since one of them, especially, was a powerful swimmer.

September 5, 2010: A Bahamian investment banker, deep-sea fishing with two friends, hooked a 12-foot tiger shark at a depth of 1000 feet. Given the shark's size and weight, the men wanted to cut it loose until, as one of the men told it: "the shark regurgitated a human foot – intact from the knee down." Too heavy (and smelly) to handle, the shark was towed until they met a Royal Bahamas Defence Force boat, which pulled the shark aboard.

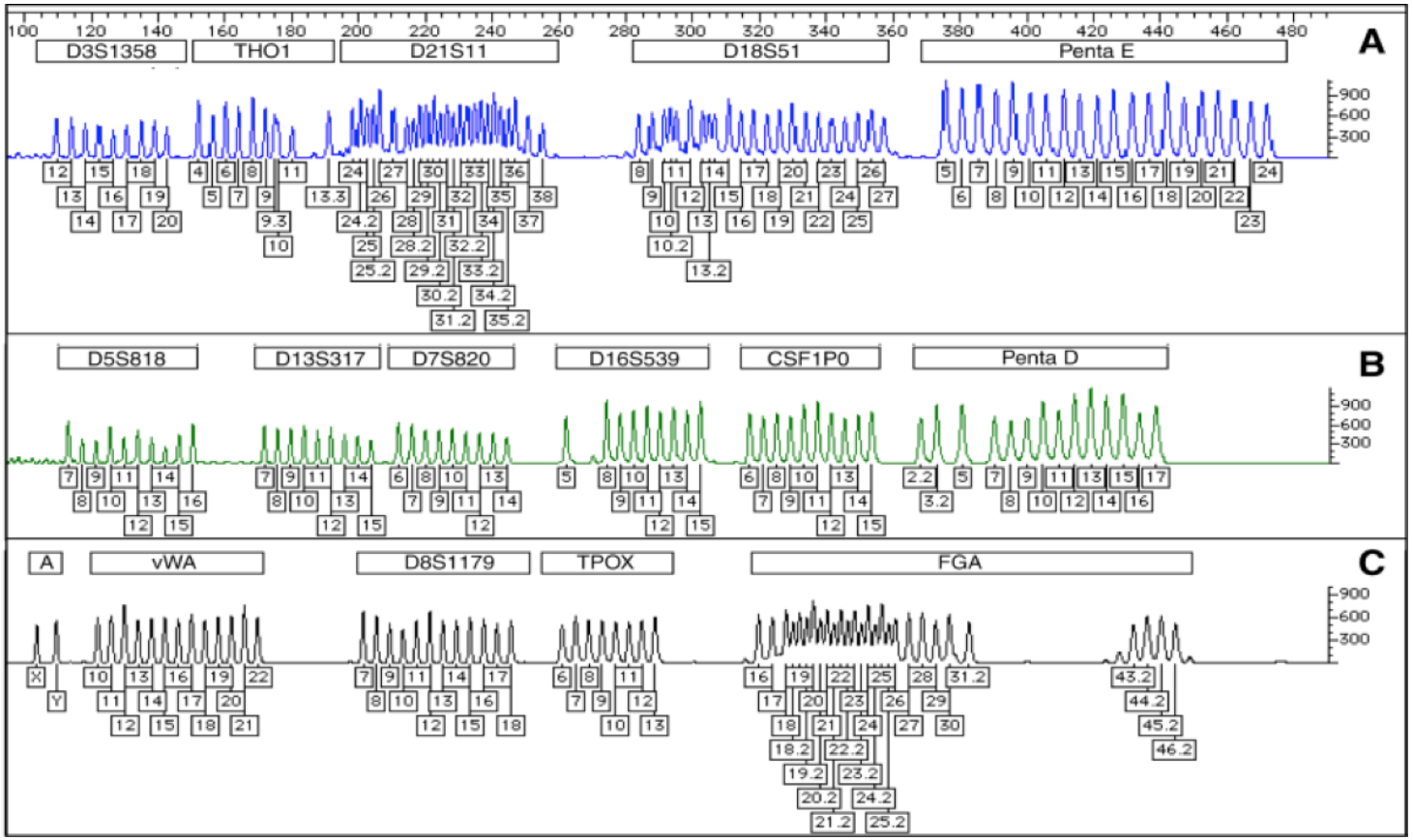
Slit open, the shark's stomach contained a right leg, two arms, and two sections of a headless torso! Was this one of the fishermen who'd disappeared the week before? Both of the fishermen? Or maybe someone else entirely (a third area man disappeared the same week)? Fingerprints made a tentative identification, but DNA analysis would clinch it. Scientists compared DNA from tissue and bone of the victim(s) with blood DNA from the daughter and son of missing fisherman #1 and the mother and half-brother of missing fisherman #2.

If you did the DNA analysis, what patterns would you look for to identify the tiger shark's final meal?

Handout 2-2: DNA Identity Analysis (Electropherogram) Using 16 Loci – Results from one individual



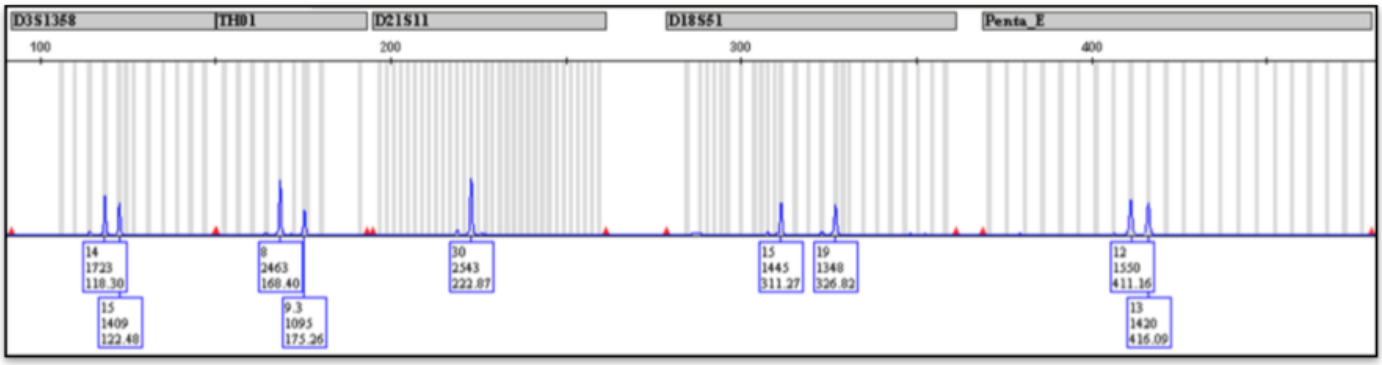
Allelic ladder – All possible results for each of the 16 DNA loci



Handout 2-3: Forensic DNA Analysis with the E-gram

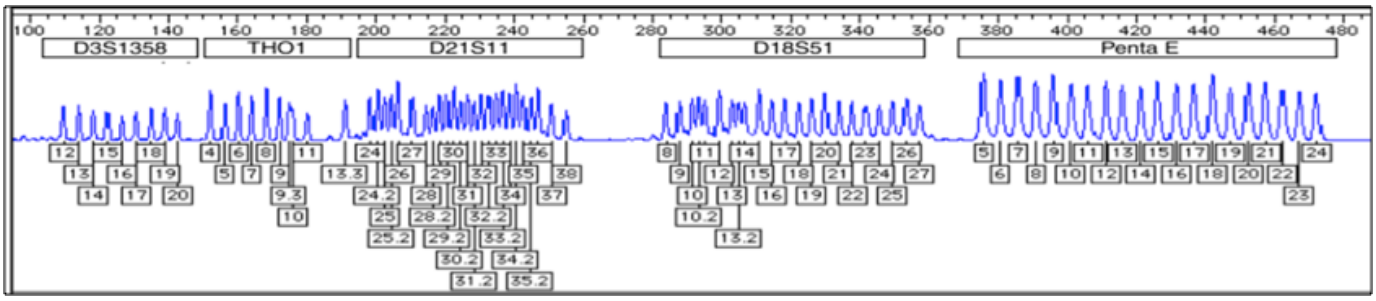
When DNA is compared from one person to another, there are millions of small sequence variations. We each have a unique set of variations, which we mostly inherit from our parents. Some variations are short sequences that are variably repeated. For example, person A might have "TCTA" repeated 10 times in one location, while person B might only have 8 repeats. These are called short tandem repeats (STRs).

To match DNA samples from a crime scene, forensic scientists analyze the number of repeats at 16 or more STR loci. Today's technology can measure up to six loci at once. Row A from Handout 2-2 (below) shows the variations at five STR loci for one person. The name of each STR locus is in the gray box.



The first STR locus (D3S1358) is on chromosome 3 where the sequences TCTG and TCTA are repeated 2 to 15 times. Scientists use polymerase chain reaction (PCR) to amplify the DNA that includes this region. The PCR products are separated by size and charted on an electropherogram (or e-gram). The peaks on the left are the smallest DNA fragments (those with fewer repeats). The peaks on the right are the largest (with more repeats).

Nine common variations are found at D3S1358. The allelic ladder e-gram below is not from one person, but shows all the possible variations at each of the five STR loci. Each variation is identified with a number. The person above has variation 14 (shown as the first number in the box below the graph) at the D3S1358 locus on one copy of chromosome 3 and variation 15 on the other.



Write the number of each variation for the remaining STR loci to create a DNA profile of this person:

STR Locus	Variation number(s)
D3S1358	14, 15
THO1	
D21S11	
D18S51	
Penta E	

Questions:

1. There are two different variations at STR locus THO1. Where did these variations come from?

2. The STR locus D21S11 only has one variation. Why?

3. The e-gram on Handout 2-2 and above is from a woman. She has variations 14 and 15 at STR D3S1358. If she has children with a man who has variations 12 and 19 at the same STR, what are the possible combinations of variations that their children would have?

Handout 2-4: Forensic DNA Analysis for Shark Scenario

Summary of STR Results.

	Sample						
Locus	**01 (Tissue)**	**02 (Bone)**	**03 (Tissue)**	**04 (Reference)**	**05 (Reference)**	**06 (Reference)**	**07 (Reference)[1]**
D3S1358	14, 16	14, 16	NR	15	16	16	15, 17
TH01	6, 9.3	6, 9.3		7, 9.3	7, 9.3	7, 9.3	6
D21S11	29, 30	29, 30		30, 31	30, 31.2	29, 30	29, 32.2
D18S51	12, 16	12, 16		17, 19	12, 13	12, 16	16, 18
Penta E	INC	8, 9		{8, 17}	5, 13	9, 11	13, 15
D5S818	8, 10	8, 10		12, 13	11, 12	10, 11	13
D13S317	11, 12	11, 12		13	12, 13	11	11, 12
D7S820	10, 11	10, 11		9, 11	9, 12	9, 10	10, 12
D16S539	INC	10, 12		8, 9	8, 11	11, 12	10, 11
CSF1PO	7, 12	7, 12		11, 12	9, 11	7, 11	11, 12
Penta D	INC	2.2, 9		8, 12	8, 14	5, 9	9, 11
Amelogenin	X, Y	X, Y		X	X, Y	X	X, Y
vWA	15, *	15, 19		16	14, 16	16, 19	14, 16
D8S1179	15	15		13, 15	14, 15	14, 15	12
TPOX	{8, 9}	8, 9		8, 11	8, 11	8, 9	8
FGA	24, 25	24, 25		20, 24	22, 25	22, 24	21, 25

*peak(s) present below reporting threshold; locus not used for comparison
{ } = peak imbalance present
INC = locus inconclusive; not used in comparison
NR = no results
[1]Sample 07 represents the fisherman's half-brother; he shares the same father but has a different mother.

Sample Codes:
01 = Tissue remains found in shark
02 = Bone remains found in shark
03 = Tissue remains found in shark
04 = Daughter of missing fisherman #1
05 = Son of missing fisherman #1
06 = Mother of missing fisherman #2
07 = Half-brother of missing fisherman #2

Reference: King, S.L. et al. DNA Identification of Human Remains Obtained from a Tiger Shark. Promega Corporation Web site. http://www.promega.com/resources/profiles-in-dna/2013/dna-identification-of-human-remains-obtained-from-a-tiger-shark/

Handout 2-5: Forensic DNA Report

Analyze the forensic DNA data on Handout 2-4 to answer to following questions and determine the identity of the person(s) inside the shark. Use what you know about patterns of inheritance to make your decisions.

1. There are two missing fishermen. Multiple human remains were found in the shark. Are the remains (Samples 01, 02, and 03) from one person, two, or three? Show your evidence.

2. Samples 04 and 05 are from the children of Missing Fisherman #1. If samples 01 or 02 are from Fisherman #1, what STR variations would you expect to see in his children inherit?

    a. Do any of the 16 STR loci suggest that samples 01 and 02 are from the father of the children in columns 04 and 05?

    b. Which of the 16 STR loci suggest that samples 01 and 02 are NOT from the father of the children in columns 04 and 05?

3. Sample 06 is from the mother of Missing Fisherman #2. If samples 01 or 02 are from Fisherman #2, what STR variations would you expect to see in him inherit from his mother?

    a. Do any of the 16 STR loci suggest that sample 06 is from the mother? Do variants match between columns 01, 02, and 06?

    b. Do any of the 16 STR loci suggest that sample 06 is NOT from the mother? Do any of the variants in samples 01 or 02 not match a pattern of inheritance from sample 06?

4. Sample 07 is from the half-brother of Missing Fisherman #2. They share a father but have different mothers. If samples 01 or 02 are from Fisherman #2, how many STR variations would you expect the half brothers to share?

    a. Do any of the variations at 16 STR loci suggest that sample 07 and Samples 01 or 02 have the same father?

    b. Do any of the variations at 16 STR loci suggest that sample 07 and Samples 01 or 02 have the a different father?

5. Look at your analysis from questions 1 through 3. Whose remains are in the shark? What is your best evidence?

6. Why are some data points missing? Do these missing data points draw any doubts on your conclusion?