1). [25 total points] You recover a blood stain at a murder scene and also obtain a DNA sample from the victim. Scoring three makers you have the following information:

Marker	Sample	Victim
1	8, 9, 11	8, 9
2	3, 5	3, 3
3	3, 6, 7, 8	6, 7

a) What evidence (if any) is there that the sample is a mixture? [5 points]

There are more than two alleles at some of the markers

b) If this is a mixture, what can you say about the number of contributors? [5 points]

There are at least two contributors

c) Suspect Bruce has genotype 11, 11 at marker 1; 5, 5 at marker 2; and 3, 6 at marker 3. If the sample is a two contributor mixture, can Bruce be excluded (why or why not)? [5 points]

Bruce is excluded, as the other contributor is a 3, 8

d) If the sample is a two-person mixture, what is (are) the possible genotype(s) of the second person (assuming the first is the victim). [5 points]

Marker 1: 8, 11;   9, 11;   11, 11
Marker 2: 3, 5;   5,5
Marker 3: 3, 8

e) If you make no assumptions about the number of contributors, what possible genotypes for marker 3 would fail to be excluded as potential contributors. [5 points]

3,3   3, 6   3, 7   3, 8
**   6, 6   6, 7   6, 8**
**   7, 7   7, 8**
**   8, 8**

2) [25 total points] Reconsider the sample from problem 1,

Marker	Sample	Victim
1	8, 9, 11	8, 9
2	3, 5	3, 3
3	3, 6, 7, 8	6, 7

Assume the following allele frequencies

Marker 1	Freq	Marker 2	Freq	Marker 3	Freq
8	0.05	3	0.1	3	0.1
9	0.1	5	0.4	6	0.05
11	0.2			7	0.2
				8	0.03

a) Assuming a two-person mixture, what is the probability that a random person would fail to be excluded as the second contributor (assuming the victim was the other contributor)? [15 points]

Marker 1: 8, 11 OR 9, 11 OR 11,11
2*0.05*0.2 + 2*0.1*0.2 + 0.2*0.2 = 0.1

Marker 2: 3,5 OR 5,5
2*0.1*0.4 + 0.4*0.4 = 0.24

Marker 3: 3, 8
2*0.1*0.03 = 0.006

Prob(Fail to exclude) = 0.1*0.24*0.006 = 0.000144 or 1 in 6944

b)   Making no assumptions as to the number of contributors, what is the probability that a random person would fail to be excluded as a contributor to the mixture? [10 points]

Marker 1 = (8 or 9 or 11) and (8 or 9 or 11) = $(0.05+0.1+0.2)^2$ = 0.11225

Marker 2 = (3 or 5) and (3 or 5) = $(0.1+0.4)^2$ = 0.25

Marker 3 = (3 or 6 or 7 or 8) and ((3 or 6 or 7 or 8)
= $(0.1+0.05+0.2+0.03)^2$ = 0.1444

Prob(Fail to exclude) = 0.11225*0.25*0.1444 = 0.0044 or 1 in 226

3) [10 Total Points] You have a crime scene with old bones and old hair that you suspect belong to a person reported missing 20 years ago.

a) What DNA marker would you use for DNA testing? Why? **[5 points]**

mtDNA, as due to the multiple-copy nature of this genome, it is much more robust to degradation than nuclear markers.

b) There is no DNA from the missing person, but his father and mother are still living. Who should you DNA test and why? **[5 points]**

His mother, as the mtDNA is passed from mother to her children.

4) [10 Total Points] You have fingernail scrapings from a rape victim who scratched her attacker. Although you can amply a few of the CODIS markers that show more than 2 alleles in this sample, most CODIS markers simply match the victim.

a) What additional DNA marker should you use in this case? Why? **[5 points]**

Y chromosomal markers, as you can amply these up against a female (victim) background.

b) You have a suspect, but they are still on the run and hence you have no DNA sample. However, his father and mother are still living. Who should you DNA test and why? **[5 points]**

The father, as Y chromosome passed from father -> son.

5) [5 Total Points] In a crime sample, you have a Y chromosome profile that is not found in a database of 2000 samples. Your suspect matches the crime sample profile. The court asks you to use the adjusted counting method when computing the match probability. What value would you report to the court?

(0+2)/(2000+ 2) = 2/2002 = 1 in 1001

6) [10 total points] Match the name and their DNA claim to fame.
Gary Dotson, Colin Pitchfork, Bruce Budowle
Kirk Bloodsworth, Tommie Lee Andrews, Alec Jeffreys

First death row inmate freed on DNA: **Kirk Bloodsworth**
First person convicted using DNA: **, Colin Pitchfork**
Invented DNA fingerprinting: **Alec Jeffreys**
First person convicted in the US using DNA: **Tommie Lee Andrews**
First convicted person freed using DNA**: Gary Dotson**
Bonus question: What is the claim to fame for the person remaining? **[extra 5 points!]**

> **Bruce Budowle is the FBI's chief DNA scientist**

7) [15 total points] Short answer/definition (1-2 sentences!) **[3 points each]**

a) What is familial searching?

Searching other family members should we get only a partial hit for our current suspect.

b) What was Snowballs' DNA claim to fame?

First use of animal DNA.

c) What is the Daubert test?

A set of criteria that scientific evidence must satisfy to be admitted in court.

d) What is CODIS?

Combined DNA Index System -- the US DNA database.

e) What is the Prosecutor's fallacy?

This is reporting the probability of being guilty given the evidence. DNA instead returns that probability that a random person would have left the Observed DNA sample