Theft at the Olympics!

The Crime

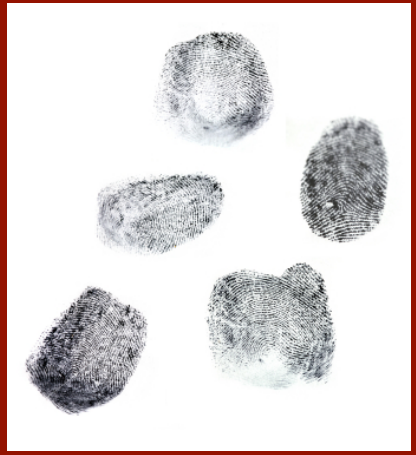
- 9:47 pm, Radisson Hotel, Beijing China
- Gold medal is stolen
- No sign of forced entry, door open
- SJ chases perpetrator for 3.62 minutes, 0.5 miles
- Security guard can't keep up

Shawn Johnson's statement

- "It's kind of stupid, but I just wanted to see my medal… you know, put it on, stand in front of the mirror…so I went back to the hotel early, and as I was coming around the corner, I heard glass breaking and saw someone running away. The guard yelled "stop thief" and I just started running after him..I'm not sure why, I guess it wasn't the smartest thing to do.. Anyway, I chased him down the street and this guy was fast! I'm a fast sprinter, but he was faster. We got to a construction site and he jumped right over the fence like it was nothing, like he jumped hurdles or vaults all the time. Once we got to the next intersection, I lost him in the crowd, and turned back to the hotel. That's when I found out that…he…he stole my medal!!"

The Evidence

- Fingerprints from 10 individuals at the crime scene
- Blood and skin collected from broken glass
- Suspect outran an Olympic gymnast – should have athletic physiology



The 9 suspects

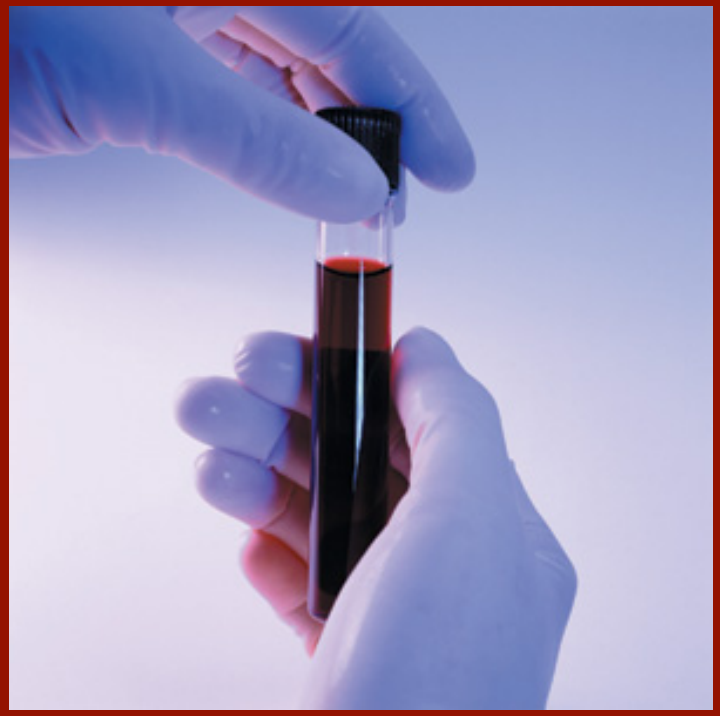
1. Russian Olympic gymnast - jealousy
2. American Olympic gymnast – revenge
3. Chinese Olympic weight lifter – apprehended running near hotel
4. Hotel security guard – didn't report for work, access to rooms
5. Spectator – Apprehended near hotel with a stolen medal
6. Hotel administrator – feud with team manager
7. Kenyan Olympic sprinter – running near hotel
8. Hotel resident #1 – had room key, no alibi
9. Hotel resident #2 – had been pestering team for autographs, no alibi

Your assignment

- Determine perp's blood type and compare to suspects
- Analyze fingerprints found at the crime scene
- Analyze ECG data to learn about suspects' physical fitness
- DNA fingerprinting of perp's tissue
- Find out whodunit!

Analyzing Blood

- A red substance was found at the scene of the crime
  - Is it blood?
  - Whom does it belong to?
  - Can it identify the perpetrator?



Part 1: Is it blood???

We will use a test that relies on components of blood to catalyze a reaction with a chemical placed on the substance to be tested

- Hydrogen peroxide, a strong oxidant
- Rules out substances that aren't blood

Catalase Test

Have you ever used hydrogen peroxide to clean a cut or scrape?

- bubbles form on your skin when the hydrogen peroxide came in contact with the blood from the wound
- Blood contains an enzyme called **catalase**, which breaks down hydrogen peroxide into water and oxygen gases (bubbles)

$2H_2O_2$ (l) + catalase → $2H_20$ (l) + O_2 (g) + catalase

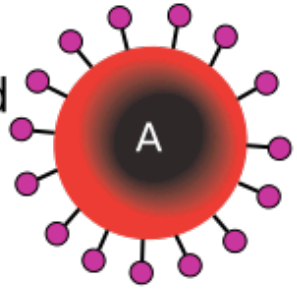
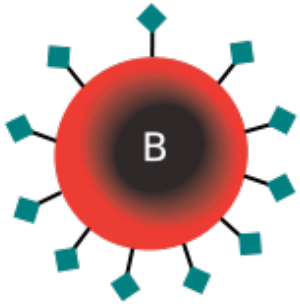
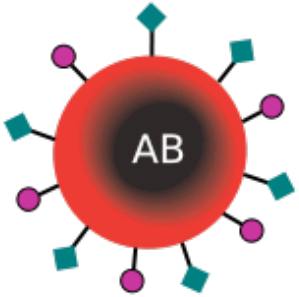
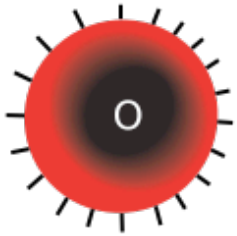
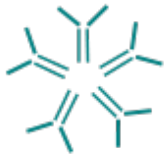
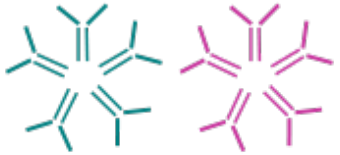
Is the material found at the crime scene blood?

Part 2: Blood Typing

- Used as an initial test to EXCLUDE some suspected sources of a bloodstain

- Example:
  - Blood stain at the crime scene contains Type A blood
  - The two key suspects have type O and type B blood
  - It can't be their blood!!

- However, many people share the same blood type
- Blood typing can exclude suspects, but won't identify the perpetrator

	Group A	Group B	Group AB	Group O
Red blood cell type				
Antibodies present	 Anti-B	 Anti-A	None	 Anti-A and Anti-B
Antigens present	 A antigen	 B antigen	 A and B antigens	None

Agglutination - Red blood cells will clump in the presence of antibodies against their antigens.

Blood Type is Inherited

Phenotype	Genotype
A	AA or AO
B	BB or BO
AB	AB
O	OO

Blood Type Test Using Serum

Reactions		Blood Type
Anti-A Serum	Anti-B Serum	
Agglutination	No Agglutination	Type A
No Agglutination	Agglutination	Type B
Agglutination	Agglutination	Type AB
No Agglutination	No Agglutination	Type O

Blood type analysis

- Determine the blood type of all 9 suspects
- Determine the blood type of the blood found at the scene
- Whom can we rule out?

Fingerprinting

Which of the suspects was at the scene of the crime?

What are fingerprints?

- an impression of the **friction ridges**
- natural secretions from the eccrine glands present in friction ridge skin

Unique & Permanent

- Even identical twins do not have the same fingerprints.
  - Friction ridges are formed during fetal development where and are unique due to genetic and epigenetic factors (maternal diet, pH, temperature, movement of the fetus, etc.).

- Friction ridges persist throughout life in their permanent arrangement

Dactyloscopy

The science of fingerprint identification

- Known prints: from a known person
  - Example: on a police record
- Latent prints: prints from a crime scene
  - Example: on a murder weapon

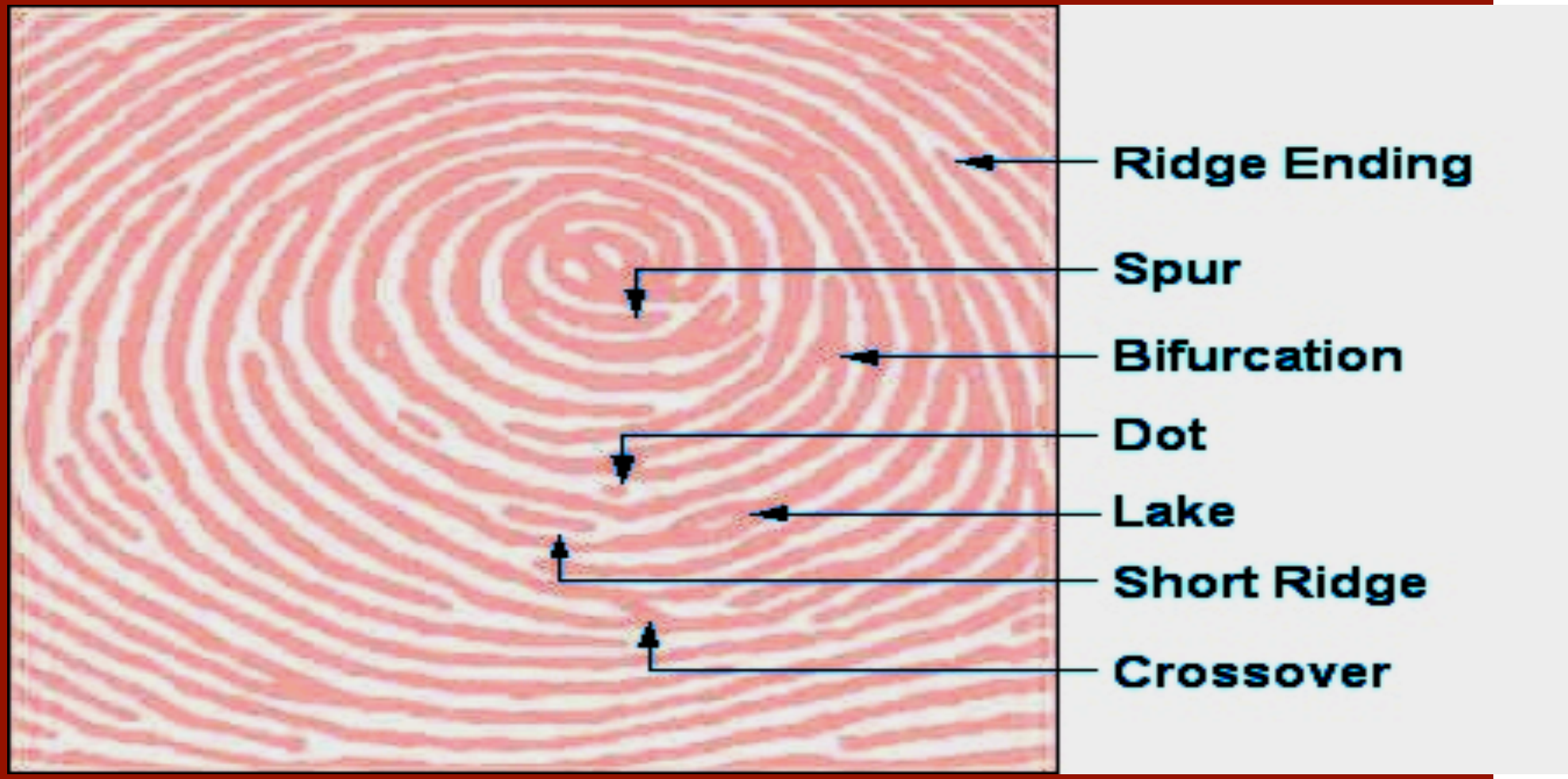
Three main patterns

Arch

Loop

Whorl

Additional patterns



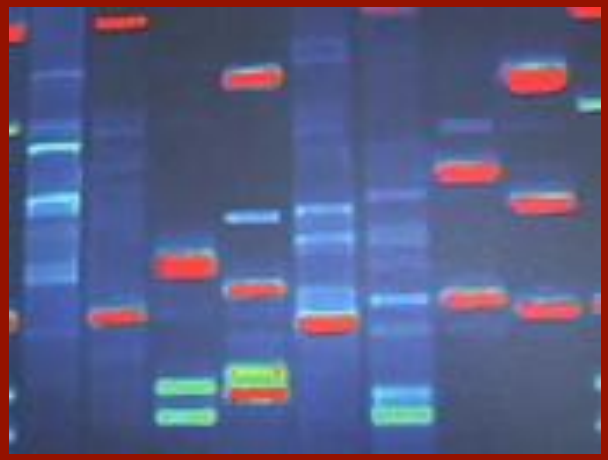
Your Assignment

1. Learn this new skill

   -examine your own prints (both thumbs and index fingers)

2. Compare latent prints from the crime scene to known prints of suspects

DNA Fingerprinting



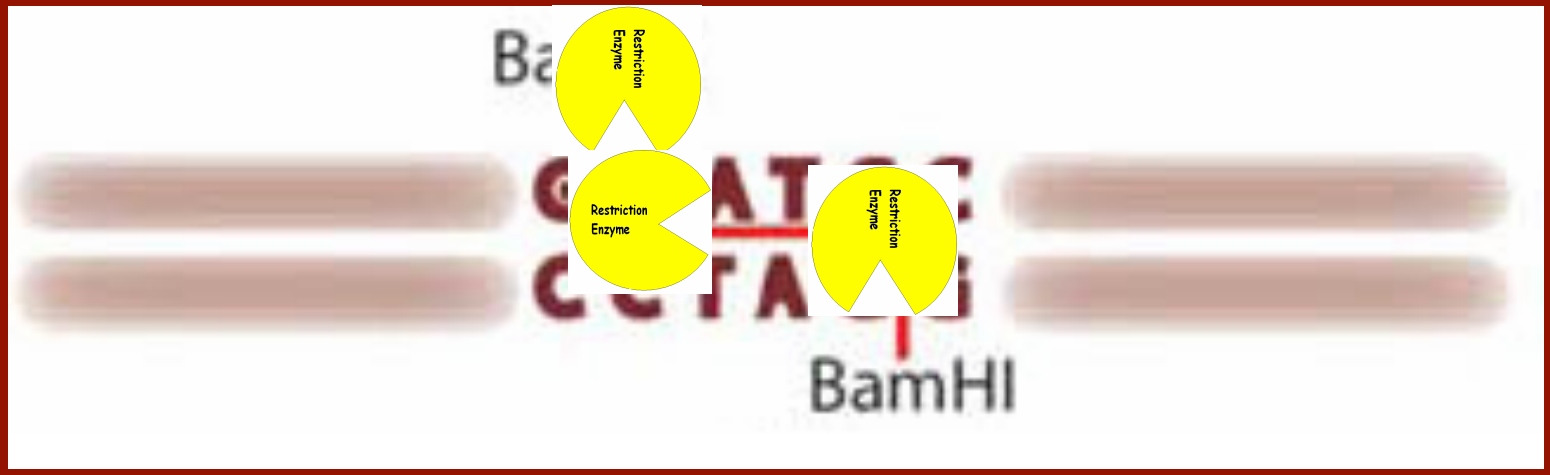
Why Use DNA Fingerprinting?

- DNA fingerprinting is a way of telling individuals of the same species apart
- DNA sequences are variable and can therefore be used as identifying characteristics.
- DNA fingerprinting has advantages over other sources of evidence (fingerprints, blood type, etc.):
  - Highly accurate.
  - Can be gathered from trace crime scene evidence.

How do you take a DNA fingerprint?

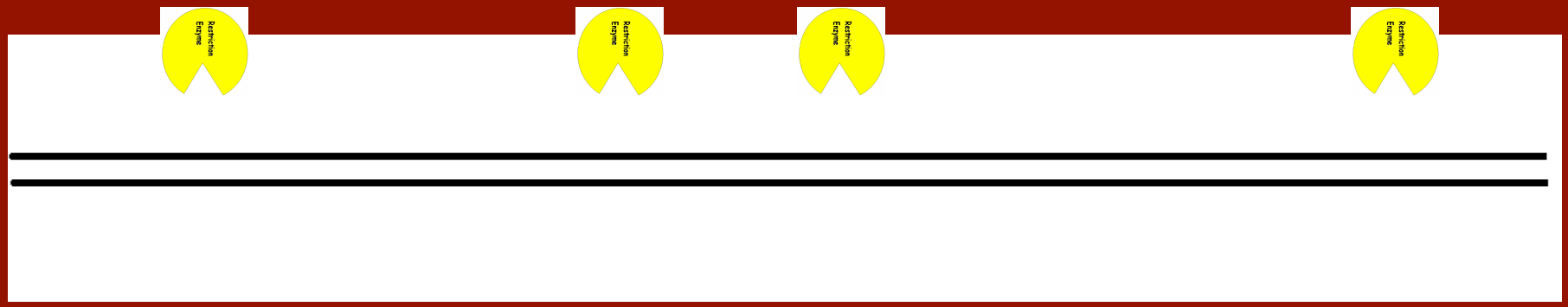
- One way: Restriction Fragment Length Polymorphisms (huh?) → aka RFLP
- Restriction enzymes are molecules that can cut DNA into pieces --> each enzyme cuts at a very specific DNA sequence
- While all human beings share roughly the same DNA sequence, there are in fact a small number of differences → these differences can be seen by restriction enzymes

RFLP Animation

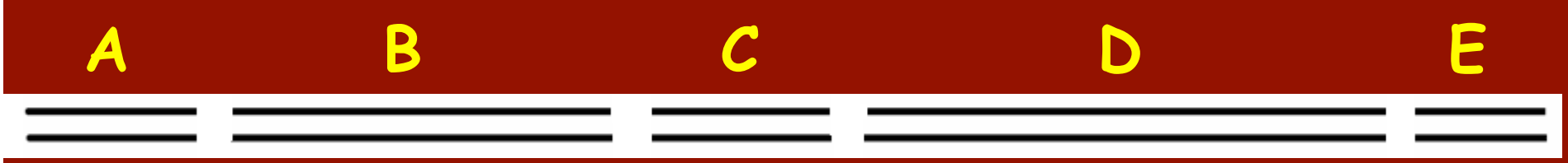


Individual 1

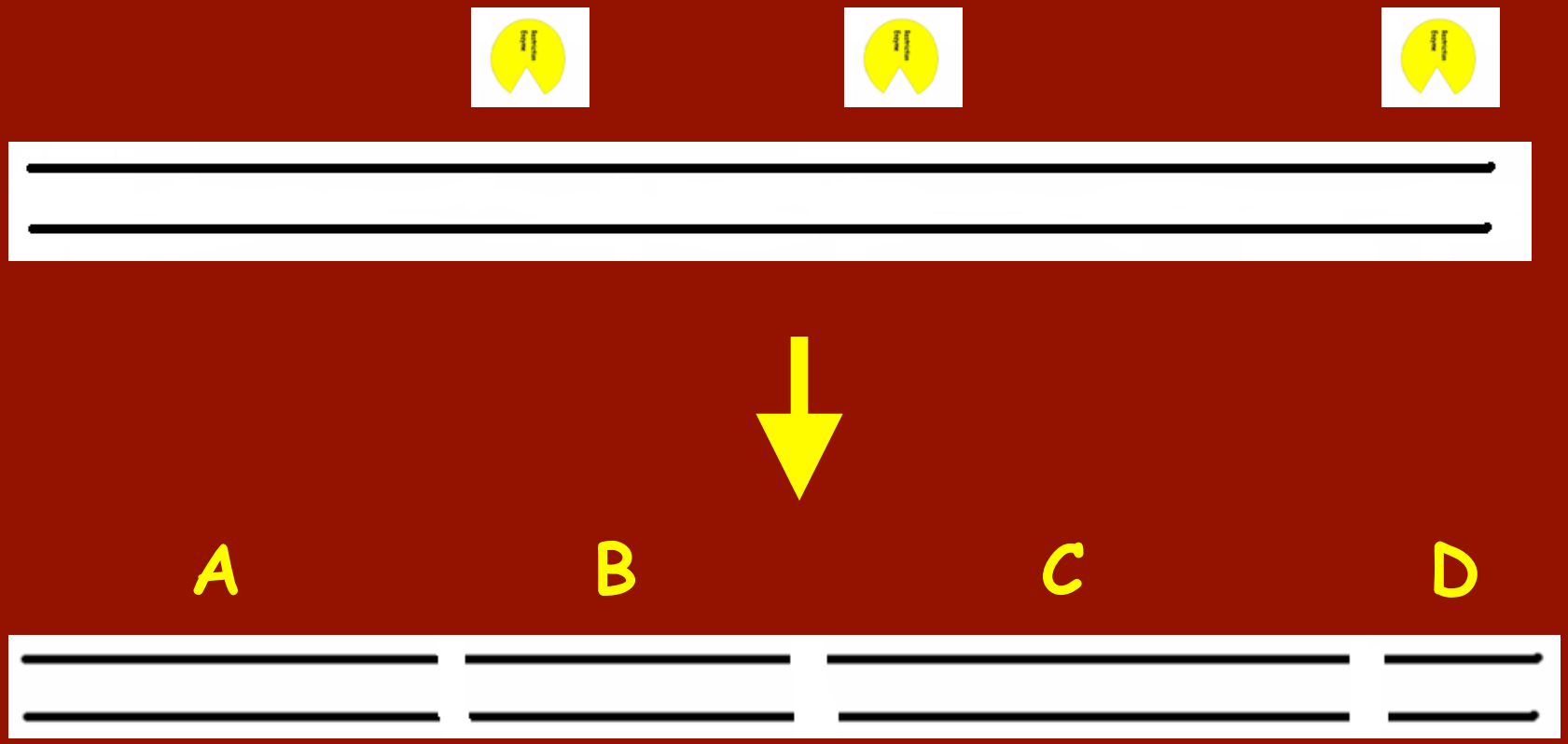
DNA



DNA Fragments



Individual 2



Individual 1 vs. Individual 2

Individual 1 DNA Fragments

Individual 2 DNA Fragments

Agarose Gel Electrophoresis

Individual 1's DNA Fragments

A

B

C

D

E

Individual 2's DNA Fragments

A

B

C

D

--

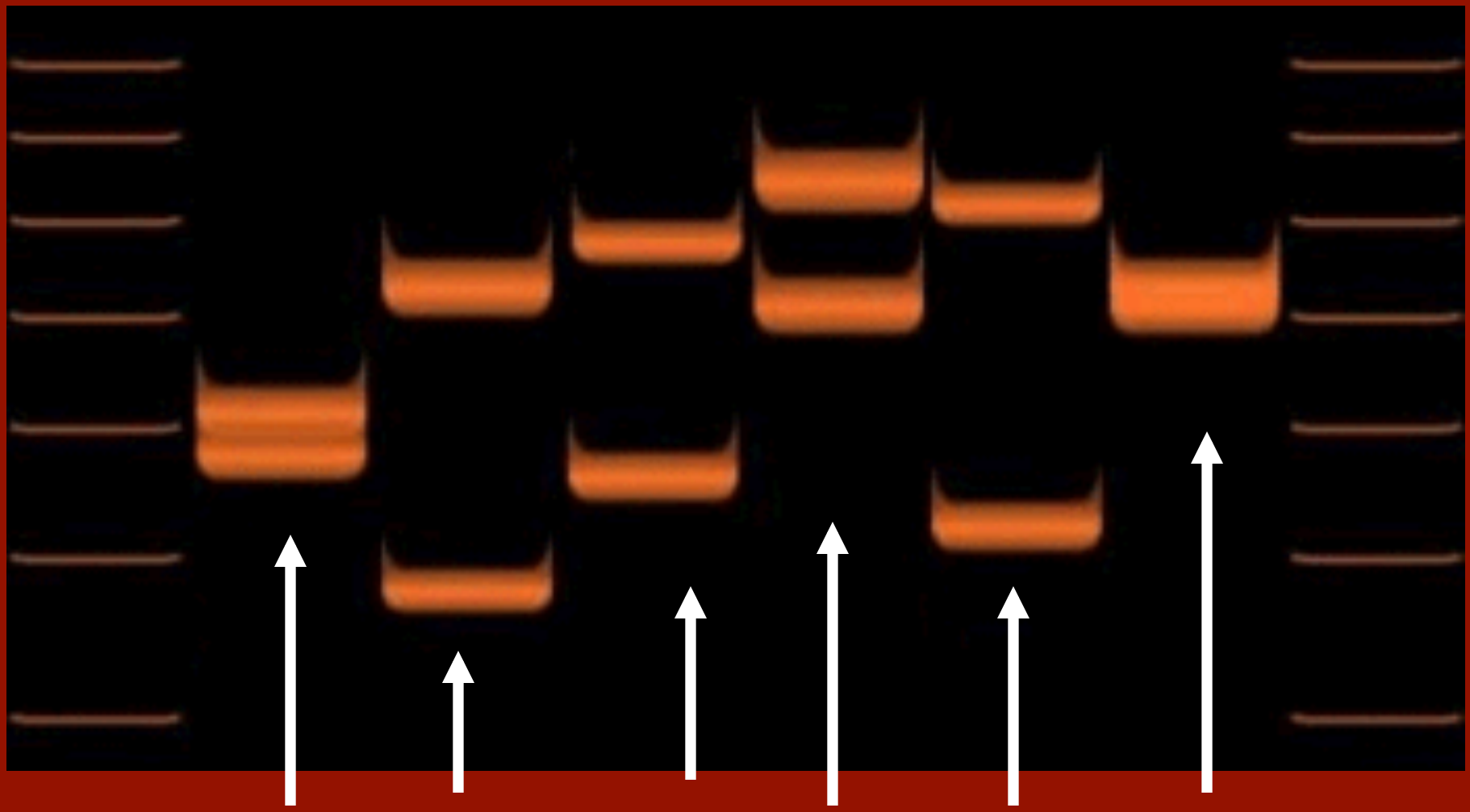
+

Wells where DNA samples are loaded

Smaller fragments will move farther through the dense gel than larger fragments, so bands near the top are bigger!

Agarose Gel

Agarose Gel Electrophoresis



Different banding patterns from different individuals

Summary

- Each individual's banding patterns should be different because the restriction enzymes will cut each person's DNA at different points
- Fragments of different sizes will travel different distances along a gel when an electric current is passed through it
- We have a blood sample from the crime scene, so we can compare the banding patterns from the crime scene sample to the patterns of our suspects and find out who was at the scene of the crime!!!

Procedure

- Each group will get 5 tubes, labeled Δ, 1, 2, 3, 4 and an agarose gel.
- We are going to “dry-load” the gel with the samples – the gels will be on the table
- Using your pipette, transfer 10 uL of the Δ sample to the first well on the left.
- Now repeat this process for the next sample in the next well, and so on, until all the samples are loaded.
- Next, carefully bring your gel over to the gel box and slowly lower it in the buffer. The side of the gel with the wells should be towards the side of the box with the black wire – the samples will run towards the red wire (the positive end)
- Once the gels have been put in the gel box, close up the gel box and press the start button on the power source.

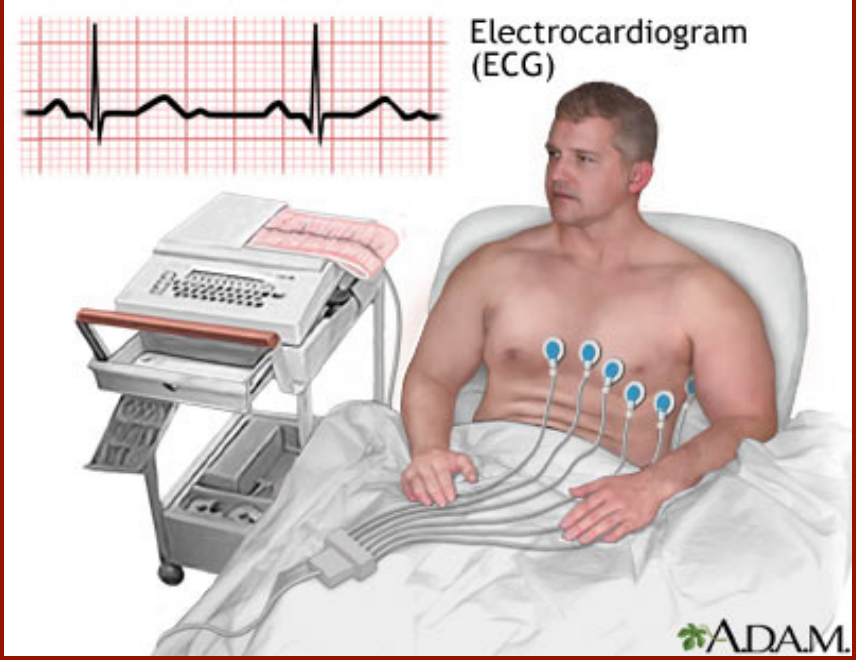
Suspect Physiology

What does it take to outrun an Olympic gymnast?

Hearts of athletes

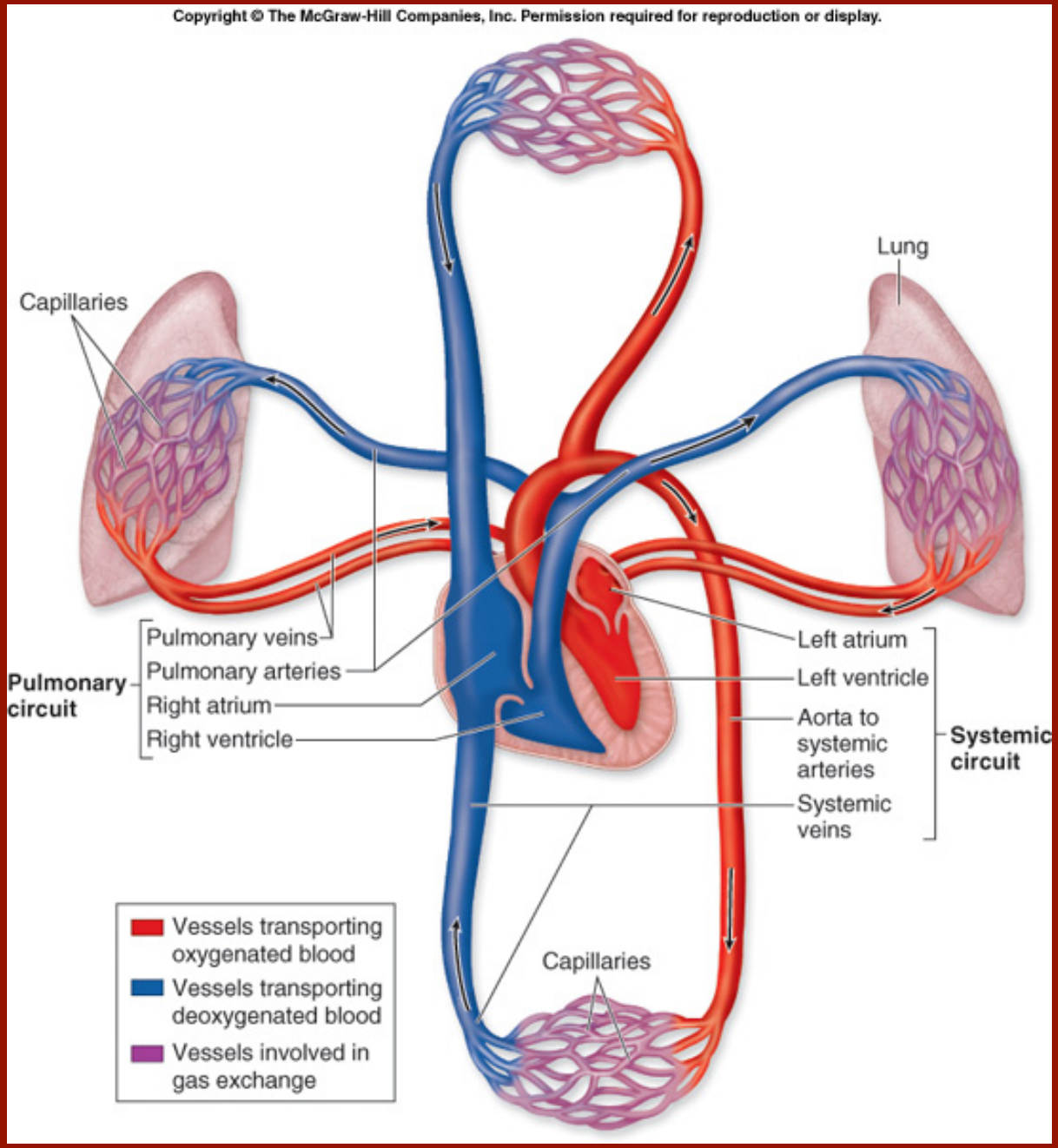
- Exercise causes the heart to get bigger, like any other muscle
- Left ventricular hypertrophy – growth of the left ventricle to supply more blood per pump
- Pumping is more efficient – lower heart rate
- Regular rhythm

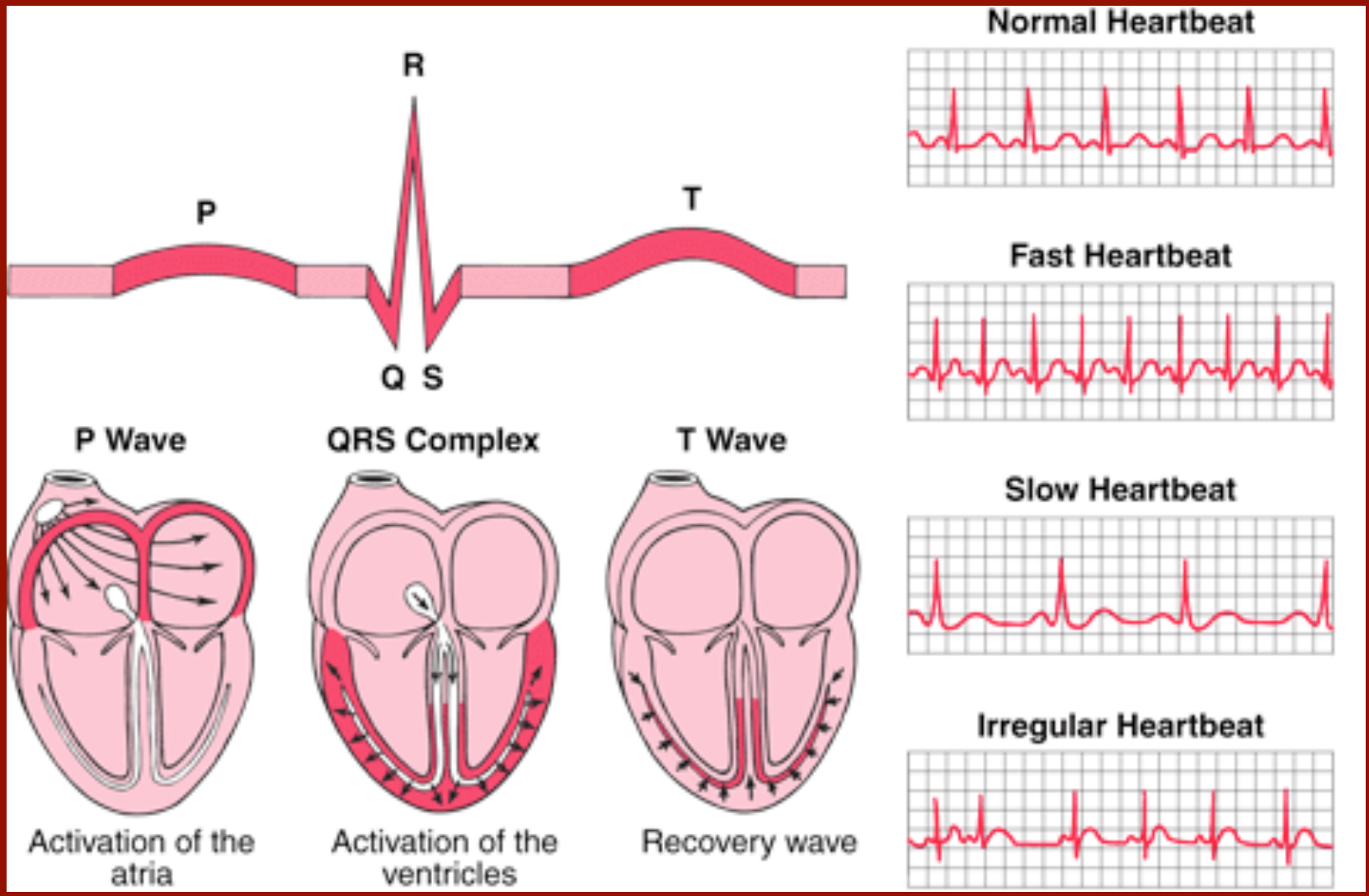
Electrocardiogram (ECG)



- Electricity causes the heart to pump
- Detect electrical waves with electrodes attached to wrists and ankles
- An Electrocardiogram (ECG)
  - measures the electrical signals in heart tissue
  - provides detailed information about the condition of the heart

We will use an ECG to determine the condition of each of the suspect's hearts




R
P
T
Q S
P Wave
QRS Complex
T Wave
Activation of the atria
Activation of the ventricles
Recovery wave
Normal Heartbeat
Fast Heartbeat
Slow Heartbeat
Irregular Heartbeat

Information from ECG signal

- Heart rate – time interval between QRS peaks
  - Too fast – tachycardia
  - Too slow – brachycardia (elite athletes)
- Heart pattern – regularity of heart rate
  - Skipping beats - arrhythmia
- Tissue damage
  - Heart attacks or damaged valves - missing or inverted waves
- Size of ventricles
  - Electrical axis of the heart
  - $< 0^o$ = Left axis deviation (left ventricular hypertrophy)
  - $>90^o$ = Right axis deviation (right ventricular hypertrophy)

Using ECG in forensics

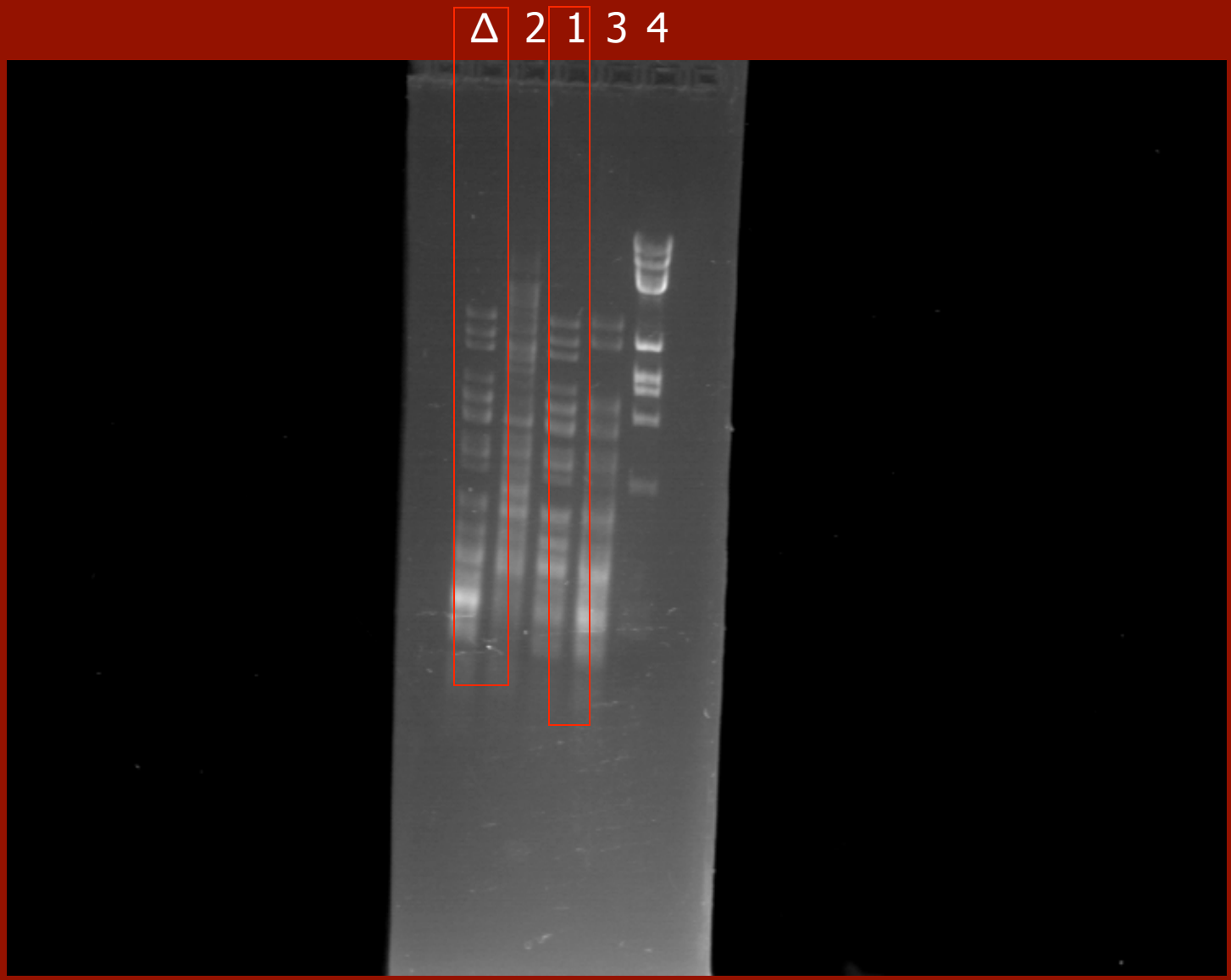
- The perpetrator outran an Olympic gymnast
  - He/she has increased cardiac fitness
  - ECG analysis should show left ventricular hypertrophy (bigger left ventricle)
  - Slower pulse
  - ECG should show no history heart disease
- Eliminate subjects who have normal or diseased ECG readings

Your assignment

- Do ECG on yourself and lean how to determine the size of the heart

DNA Fingerprinting Results

Actual Picture of Bands



Who is the thief?

- Review the evidence
- Analyze the results of each test
- Make your conclusions!