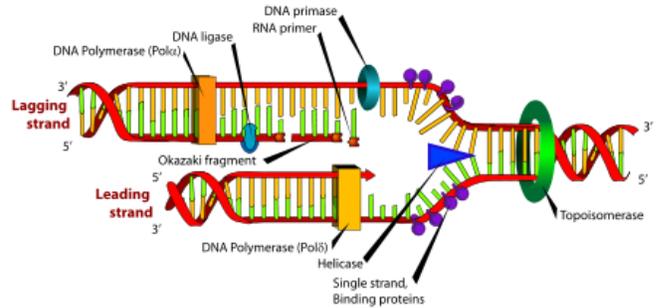


1.3. Identity: Molecules and Cells Study Guide

1.3.a What is the structure and function of DNA?

DNA stands for **deoxyribonucleic acid**. Its name comes from the fact that the sugar in it is deoxyribose and it is made up of building blocks of nucleic acids (just like RNA). It is a double-stranded helical molecule that the chromosomes in the nucleus of our cells are made of. DNA makes up genes, which make up chromosomes. Each gene codes for a protein (like hemoglobin), and each protein determines a trait (like oxygen-carrying red blood cells).

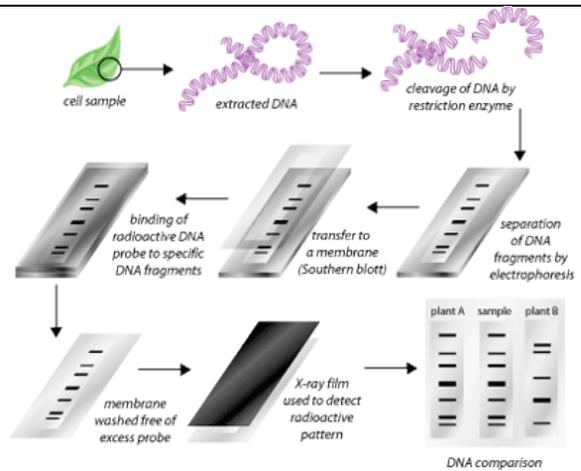


1.3.b How does DNA differ from person to person? 1.3.c What role does DNA play in our identity? 1.3.i How can the field of biometrics be used to verify and protect identity?

More than 99.9% of the DNA of each person matches the DNA of every other person. Scientists can analyze the small bits that differ to determine who DNA came from, though.

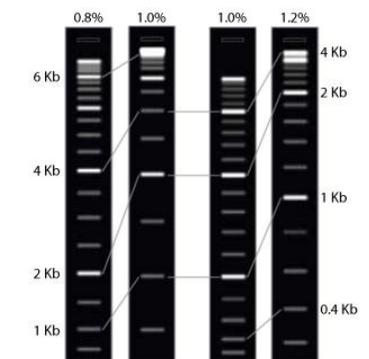
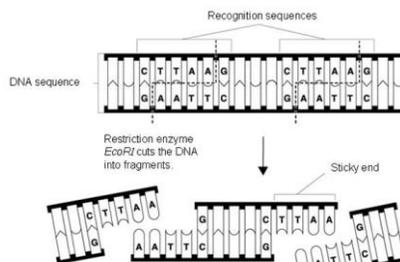
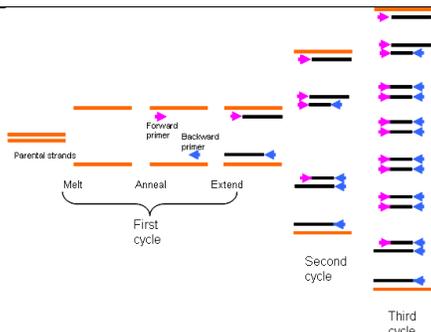
DNA analysis is one form of **biometrics** ("life measurement") and can be used to tell individuals apart. Only identical twins have 100% identical DNA, so for everyone else our DNA is as unique as our fingerprints.

Other forms of **biometrics** include iris scans, voice analysis, fingerprinting, gait measurement, facial recognition, etc. They can be used to protect accounts, keep babies from being taken from the wrong parents out of hospitals, protect national security, etc.



1.3.d How can tools of molecular biology be used to compare the DNA of two individuals?

DNA can be extracted from a person & then scientists can perform **PCR (polymerase chain reactions)** to amplify the DNA, making a sample millions of times bigger than the original sample. They can then cut the DNA with **restriction enzymes** and run the samples through **gel electrophoresis** to analyze the size of each DNA fragment. Because the DNA of each individual is unique, the restriction enzymes will cut each person's DNA in a different place, so the **RFLPs** will look different on the gels.



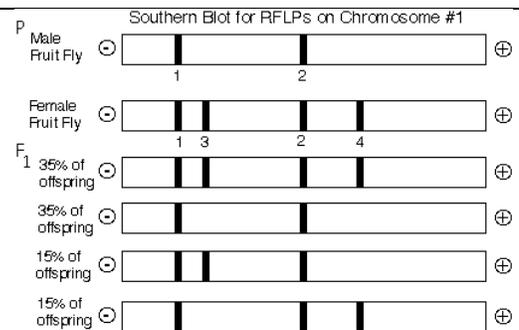
1.3.f What are restriction enzymes?

Restriction enzymes come from bacteria (mostly) and are chemicals they are thought to use to break down the DNA of invading viruses. Geneticists use them to cut DNA into smaller fragments called **Restriction Length Polymorphisms**.

Some restriction enzymes			
Enzyme	Source organism	Restriction recognition site in double-stranded DNA	Structure of the cleaved products
(a) EcoRI	<i>Escherichia coli</i>	$\begin{array}{c} 5' \text{---} \text{G} \text{---} \text{A} \text{---} \text{A} \text{---} \text{T} \text{---} \text{T} \text{---} \text{C} \\ \text{---} \text{C} \text{---} \text{T} \text{---} \text{T} \text{---} \text{A} \text{---} \text{A} \text{---} \text{G} \text{---} 5' \end{array}$	$\begin{array}{c} \text{---} \text{G} \text{---} \qquad \qquad \qquad 5' \text{---} \text{A} \text{---} \text{A} \text{---} \text{T} \text{---} \text{T} \text{---} \text{C} \text{---} \\ \text{---} \text{C} \text{---} \text{T} \text{---} \text{T} \text{---} \text{A} \text{---} \text{A} \text{---} \text{G} \text{---} \qquad \qquad \qquad 5' \end{array}$ <p>5' overhang</p>
PstI	<i>Providencia stuartii</i>	$\begin{array}{c} 5' \text{---} \text{C} \text{---} \text{T} \text{---} \text{G} \text{---} \text{C} \text{---} \text{A} \text{---} \text{G} \text{---} \\ \text{---} \text{G} \text{---} \text{A} \text{---} \text{C} \text{---} \text{G} \text{---} \text{T} \text{---} \text{C} \text{---} 5' \end{array}$	$\begin{array}{c} \text{---} \text{C} \text{---} \text{T} \text{---} \text{G} \text{---} \text{C} \text{---} \text{A} \text{---} 3' \qquad \qquad \qquad \text{---} \text{G} \text{---} \\ \text{---} \text{G} \text{---} \qquad \qquad \qquad 3' \text{---} \text{A} \text{---} \text{C} \text{---} \text{G} \text{---} \text{T} \text{---} \text{C} \text{---} \end{array}$ <p>3' overhang</p>
SmaI	<i>Serratia marcescens</i>	$\begin{array}{c} 5' \text{---} \text{C} \text{---} \text{C} \text{---} \text{C} \text{---} \text{G} \text{---} \text{G} \text{---} \text{G} \text{---} \\ \text{---} \text{G} \text{---} \text{G} \text{---} \text{G} \text{---} \text{C} \text{---} \text{C} \text{---} \text{C} \text{---} 5' \end{array}$	$\begin{array}{c} \text{---} \text{C} \text{---} \text{C} \text{---} \text{C} \text{---} \qquad \qquad \qquad \text{---} \text{G} \text{---} \text{G} \text{---} \text{G} \text{---} \\ \text{---} \text{G} \text{---} \text{G} \text{---} \text{G} \text{---} \text{C} \text{---} \text{C} \text{---} \text{C} \text{---} \qquad \qquad \qquad \text{---} \text{C} \text{---} \text{C} \text{---} \text{C} \text{---} \end{array}$ <p>Blunt ends</p>
(b) HaeIII	<i>Haemophilus aegyptius</i>	$\begin{array}{c} 5' \text{---} \text{G} \text{---} \text{G} \text{---} \text{C} \text{---} \text{C} \text{---} \\ \text{---} \text{C} \text{---} \text{C} \text{---} \text{G} \text{---} \text{G} \text{---} 5' \end{array}$	$\begin{array}{c} \text{---} \text{G} \text{---} \text{G} \text{---} \qquad \qquad \qquad 5' \text{---} \text{C} \text{---} \text{C} \text{---} \\ \text{---} \text{C} \text{---} \text{C} \text{---} 5' \qquad \qquad \qquad \text{---} \text{G} \text{---} \text{G} \text{---} \end{array}$ <p>Blunt ends</p>
HpaII	<i>Haemophilus parainfluenzae</i>	$\begin{array}{c} 5' \text{---} \text{C} \text{---} \text{C} \text{---} \text{G} \text{---} \text{G} \text{---} \\ \text{---} \text{G} \text{---} \text{G} \text{---} \text{C} \text{---} \text{C} \text{---} 5' \end{array}$	$\begin{array}{c} \text{---} \text{C} \text{---} \qquad \qquad \qquad \text{---} \text{C} \text{---} \text{G} \text{---} \text{G} \text{---} \\ \text{---} \text{G} \text{---} \text{G} \text{---} \text{C} \text{---} 5' \qquad \qquad \qquad \text{---} \text{C} \text{---} \end{array}$ <p>5' overhang</p>

1.3.g What are restriction fragment length polymorphisms?

Restriction fragment length polymorphisms are also called **RFLPs** and are the bits of DNA after the long strand has been cut by restriction enzymes. They're what we see on the electrophoresis gel.



1.3.h What is gel electrophoresis and how can the results of this technique be interpreted?

Gel electrophoresis ("to carry across with electricity") is how **RFLPs** get separated. DNA molecules have a negative charge (because of the phosphates). They are attracted to a positive charge. DNA samples are placed in wells within an **agarose** gel and the DNA is near a negative electrode. When the electricity is started, they move toward the positive electrode. Smaller bits are lighter and travel faster, so the bits get separated by size. This makes it possible to tell individuals apart.

