Genetics

Friday evening 4-4:30 pm: Review structure of DNA

Grab:
white tube (phosphate)
pentagon
colored tube
Construct a nucleotide.
Find a partner to your left and right: describe how you would join up to make 1 strand of DNA with your 3 nucleotides.

Now: find another group of 3:
You may have to go back to the box: but you want to have 2 strands of DNA that will specifically base pair down the middle.

DNA has 2 roles: what are they?

Specific base pairing (which is_____)
is extremely important for which?

4:30-5:00pm Introduction to DNA Fingerprinting and restriction enzymes

We don't all have exactly the same DNA
Although most of human DNA is the same from one person to the next (we all share having the same digestive enzymes for the most part, and we all can make muscle proteins, but there are some variations from one person to the next); we're not identical, so our DNA isn't identical.

The vast majority of our DNA is non-coding: it isn't the instructions to make specific proteins, but instead serves other purposes or we don't know what it is for yet.

We can use our genetic differences to determine paternity for example, or in crime scene investigation to id suspects. That's what we're going to do today.

But, how do we "see" what letters someone has? How can we tell when the letters are different from one person to the next?

To answer that, some really smart people noticed something about bacteria and viruses.

Bacteria, Viruses and Restriction enzymes

First: a review: enzymes belong to 1 of our four classes of biological molecules. Remember, 3 of our 4 biological molecules we know from our diet.

They are:

Remember proteins do most of the jobs in a cell: they are what our DNA contains the instructions to make.

Enzymes are proteins that make chemical reactions go more quickly: like digesting food.

Ok: back to bacteria. Bacteria, like *E. coli* found in our gut, can get infected by viruses just like us. Only for bacteria, it is way more bad news: If we get a virus like a cold, sure some of our cells die, but usually we make it. If a bacterium gets infected as a single celled free living organism: it's game over.

So how do bacteria in the wild fight off viruses? One way is **restriction enzymes.** These are molecular scissors that cut DNA (and if you cut the viruses instructions in DNA, then the virus can't function): but, they don't just cut any DNA, they cut DNA at SPECFIC SEQUENCES! HOW COOL IS THAT?

One of the first RE to be identified was named EcoRI (What bacterium do you think its from?)

It has the recognition site of:
GAATTC
CTTAAG

So will cut up DNA any place it sees that sequence:

GCTTA**G|AATT C**TTCAG

CGAAT**C TTAA|G**AAGTC

(recognition sites are always palindromes)

Using RE's to for ID genetics
How does this help?

Well what if someone had a **mutation:** a change in a DNA sequence? (Most changes are neither bad nor good because often they don't affect DNA that contains instructions for a specific protein. There are some bad mutations, and a very few X-men mutations as well. It just depends: think of mutations like taking a hammer to a motorbike: often won't have much of a differences. Sometimes it'll be bad, and maybe very occasionally, it'll help)

So, lets imagine that someone has a change in the sequence above, so it's not the same as what is show. Instead of having a C they have a T in the recognition site (and then we'll designate the location of the change, so lets say this is 256 bases into the sequence: so some individuals have C at 256, some have a T.

Let's see what difference that makes:

C at 256:
GCTTA**G|AATT C**TTCAG

CGAAT**C TTAA|G**AAGTC

If you add EcoRI to a DNA sample from this individual it will get cut into 2 pieces.

T at 256:
GCTTA**GAATT**T**T**TCAG

CGAAT**CTTAAA**AAGTC

(note the bottom strand is also different at this stage)

Now the recognition site (GAATTC) is gone, and ECoRI WILL NOT cut this DNA sequences in this individual.

So, in the top example, we'll have 2 shorter fragments of DNA: if we just include the bases shown we'll have:
1 fragment that is 6 bases and one that is 10

In the bottom example we'll have just the 1 longer fragment that is 16 bases long.

How does this help us? It turns out, we can separate out DNA fragments by size in an electrical field (which is what we'll do tomorrow).

(Different RE's cut at different sites: we'll also use PstI
C TGCA|G
G|ACGTC

So, what we're going to do in lab today, is apply some molecular scissors: restriction enzymes to a sample of DNA found at a crime scene, plus 5 potential suspects, to see who's DNA matches.

Molecular Cooking: using pipettemen (micropipettes)

Lab work is a lot like following a recipe: you add specific amounts of various things together in one pot. Same idea here: just we're going to add very small liquid amounts of things: to do that we use micropipettes.

These are good for volumes less that 1 ml.
1 ml= 1000 microliters

Here's a brief video of using pipettemen in class: we'll practice first, and then use them to add restriction enzymes to our DNA samples:
Using pipettemen

- https://www.youtube.com/watch?v=352RiEMekJU

5:00pm-6:00pm Labs Introduction to Pipettemen and set up RE digest

We need to jump right in because we have a limited amount of time: please make you way quickly to the lab:
Lab groups based on base you selected.

Follow instructions given in lab
Part 1=pipettmen lab
Part 2: in DNA Fingerprinting page 27-30

Bacteria like *E. coli* often like human body temperature (37 degrees C), so we'll incubate the digests at that temp: their enzymes function best in the environment they live in.

6:00pm-7:00pm Symposium: Gel Electrophoresis

Agarose is a sugar found in sea weed: so essentially the gel is like really thick jello.

DNA fragments can move through the tiny spaces in the gel: but why would they move?

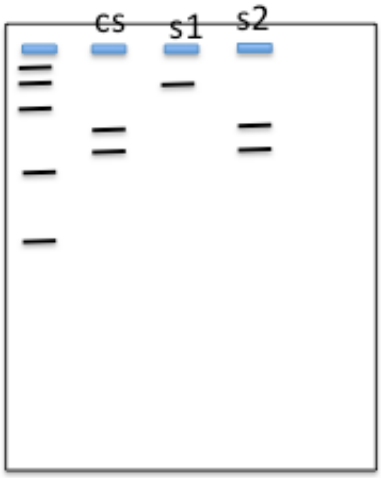
We put them in an electrical field:

Side view of gel:
DNA is negatively charged because of the phosphates in the backbone.

Now, imagine a plinko board with a quarter verses a Frisbee: which gets through more quickly? Smaller fragments will migrant further!

We can also compare sizes of what we just cut by including something we know the size of: that was the point of the "ladder."

Ok, so what might our results look like in the end:



Which samples got cut?

Which suspect matches?

You load your DNA into a little whole in the matrix: a well. It is made by inserting a comb in when you pour the gel.

DNA doesn't have much of an appearance, so we added loading dye to add color and weight so it sinks into the well.

We'll have to stain the gel to visualize the DNA before you can see the results. That will be the next step for some of you.

- loading a gel

https://www.youtube.com/watch?v=Wwgs-FjvWlw

Saturday am 8-9am Labs: separating DNA fragments by size: gel electrophoresis)

Lab 102: Load and run gels Page 32-33 and questions on 34
Lab 104: Make gels (not in lab handout)

9:00-10am: Symposium: Introduction to Chromosomes, and Inheritance

Introduction to Chromosomes

We need to understand how we end up with the mutations we have. Although we have a few unique ones, mostly we inherit the ones we have from our parents. In order to understand that, we need to talk about Chromosomes.

So, we know that we reproduce sexually: which means it takes 2 parents to make 1 offspring. We know we get ½ of DNA from mom and ½ from dad, but how does that work?

We've seen DNA get copied (one strand serves as a template for a new strand), but we haven't seen how it gets passed on. To see that, we need to zoom out to look at chromosomes.

DNA essentially is a long string of letters all attached together. WE can't see a single strand of DNA (imagine way finer than a spiders web), but how would you organize a long string?)

Wrap it up! Take string and start coiling it

These condense tightly when a cell is being duplicated to something that is visible with a light microscope: a chromosome (normally the DNA is spread out because the cell is using it).

Think of a strand of DNA like a spider web: hard to see. But what happens when it gets coiled up: it becomes visible.

It turns out DNA as a string is divided into linear chapters called Chromosomes.

When DNA gets really condensed (think about packing up all your papers at the end of the day), it becomes visible as chromosomes.

We have chromosomes in pairs: we have 23 pairs, or 46 chromosomes. (each contains 1000's of instructions for different proteins).
Chromosomes come in pairs, so you get 1 SET from Mom and 1 set from Dad.
Introduction to Meiosis: forming egg and sperm
(meiosis socks).

Forming gametes:
I have 46 chromosomes
My mom has 46 chromosomes
My dad has 46 chromosomes.

I get ½ my DNA from mom ,and ½ from dad.

Problem?

Egg and sperm are different from all other cells in our body: they only have 1 set of chromosomes (in our case 23).
Process of dividing up the DNA to make egg and sperm is called **meiosis.**

Although the set you get from Mom and Dad are VERY similar to each other, they each contain some differences (mutations), which is why your mom and dad aren't identical to each other.

10:00-11 Labs Loading and staining gels

Lab 102: stain gels pages35-37
Lab 104: load gels pages 32-34

11-12:00 Symposium: Gail and Steve

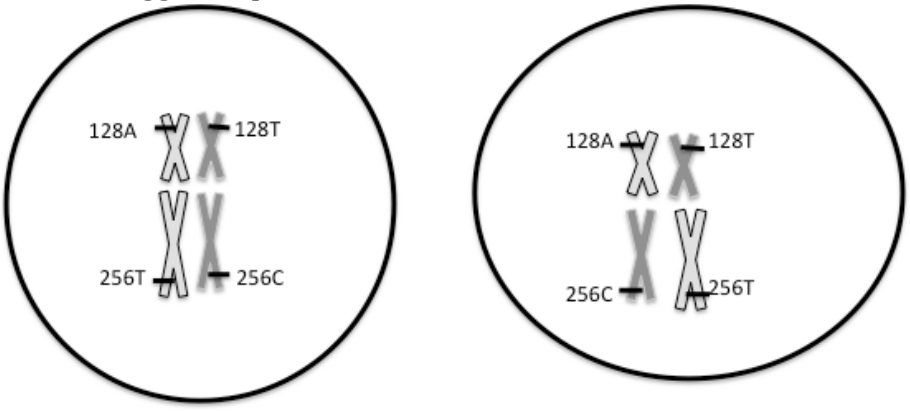
12:15-1:15 Labs: Staining gels and analyzing results

Lab 102: analyze results pg 40-41
Lab 104: stain gels (results will later be brought to you in the symposium); 35-37; 40-41

1:15-3: Symposium: Inheritance and Tying it all together

Note: if you stained your gels last, we'll get the results to you here!

Meiosis 20 minutes
When forming egg and sperm, chromosomes behave like what you did the sock pairs: chromosome pairs get together. Then they separate and go on to form different egg and sperm:



Inheritance of Alleles: 40 minutes
Ok, so how did our different suspects end up with different mutations to start with? They inherited them from their parents.

What does this look like?

To do that, we'll do an exercise with mutations in DNA.

We'll be really silly, and pretend each different mutation corresponds to some imagined trait (in fact, human traits are more complicated than this):
So We have a gene for sock color, and you get 2 versions of that gene (called alleles).
So gene=sock color
Allele1=Aqua
Allele 2=Green
Mutation at position 128=sock color
A= Aqua socks
G=green socks

Mutation at position 256=pant color
T= tan pants
C= charcoal pants

Mutation at position 312=shirt color
A=Aqua shirt
T=tan shirt

We'll have 4 "grandparents". They have chromosomes in pairs, so they get alleles for sock, pant and shirt color

#1
128A 256T 312A
128A 256C 312A

#2
128A 256C 312A
128G 256C 312T

#3
128A 256T 312A
128G 256T 312T

#4
128G 256T 312T
128G 256C 312T

(Each gets 4 cards for each of those alleles)
(write down what you have)

16 parents: your job is to get 1 copy of 128, 256 and 312 from 1 grandparent and 1 copy of 128, 256, and 312 from another. If you don't get all 3 positions it would be like you didn't have socks, or pant)

(why one from each only? Imagine one parent makes an egg, the other a sperm). Write down what you received.

Grandkids (20+): You will get 1 copy of 128, 256 and 312 from 1 parent and 1 copy of 128, 256, and 312 from another. If you don't get all 3 positions it would be like you didn't have socks, or pant)

Ok: How many of you have (or had) 128A and 128A? 128A and 128G? 128G and 128G?

Get in groups: AA, AG, GG

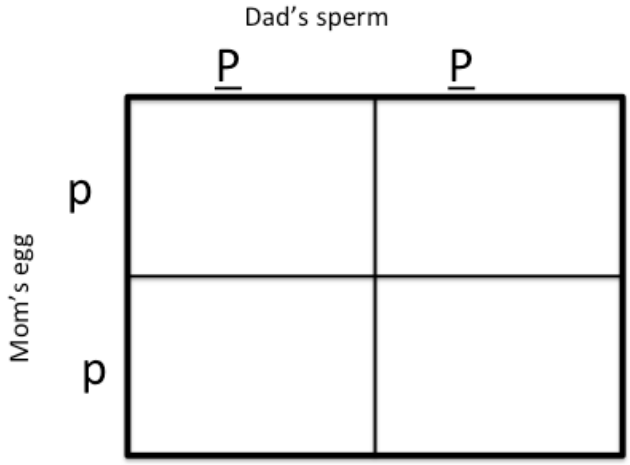
Next, within that group, divide up again:
256T and 256T? 256T and C? 256C and C?

And one more time:
312Aand A, 312A and T, 312 T and T

How many are identical? And this was starting with 4 grandparents: sort of an in breeding situation.

The more different DNA positions you look at, the easier it is to ID an individual.

Punnett Squares/multiple alleles
What we just examined is mostly true for parents, and maybe you remember doing something similar with pea plants:
Flower color: purple and white alleles:



And this is all correct—the same happens for us, BUT the difference is, we haven't been carefully bred over generations for flower color or any other traits.

So, in us, it turns out most of our traits are the result of multiple alleles at different genes.

One way to know: if there is continuous variation for a character:
IF we did only have 1 gene for height, with two alleles:
T=tall
t=short
We don't have people who are 5 foot and people who are 6 foot. This tells us more than 1 gene is involved.

Same with eye color: we don't have just blue and brown—there's a ton of variation in between. So we see a distribution of different appearances.

Family History Lesson May Answer Questions Raised in Biology Class

Oct 10, 2016 - Letter 2 of 2

DEAR ABBY: We have been learning about genetics in my biology class and how you have to get two recessive genes from your parents to have the recessive trait, like red hair. I thought it was cool, so I tried to figure out which traits I got from my parents.

Now I am freaked out because there were several traits I have that I could not have gotten from them! At least one of my parents must have been someone else. I asked my teacher without being specific, and she said I was right. Now I don't know what to do. I wonder if I came from an affair that maybe my dad doesn't know about. Do you think I should ask? -- LEARNED TOO MUCH IN PORTLAND, ORE.

DEAR LEARNED TOO MUCH: Yes, I do. But the people you should talk to are your parents, to get the full history on family traits of relatives from other generations you may not know about.

Extra notes:

Jeopardy for DNA

To play:
jeopardylabs.com/play/structure-and-function-of-dna-ade

to edit:
jeopardylabs.com/edit/structure-and-function-of-dna-ade
Jeopardy: password is ADEgrant

Answers (so you can tell a group they're wrong before reviewing an answer:

Cat	Structure of DNA	Roles of nucleic acids	Transcription	Translation	Structure of RNA
100	G AT C	DNA	nucleus	ribosome	one
200	2	DNA	gene	Ribosome (in cytoplasm)	G, A, C and U
300	Specific base pairing	rRNA	RNA	anticodon	nucleotide
400	Sugar-phosphate backbone	tRNA	Specific base pairing (hard)	codon	Sugar-phosphate
500	H-bond	mRNA	Gene expression	Amino acids	U