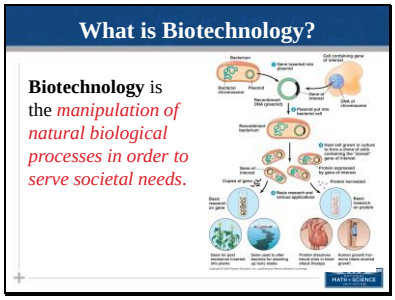
Slide 1

This is just meant to be a funny introduction.

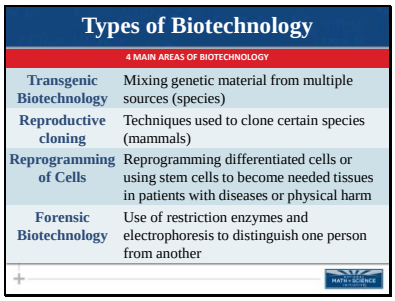
"Chipmuntula"

Slide 2



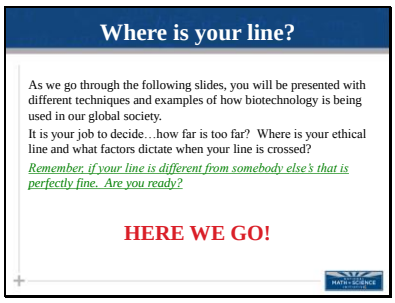
Briefly go over what biotechnology is and a brief overview of some of the "products" that we have been able to produce.

Slide 3



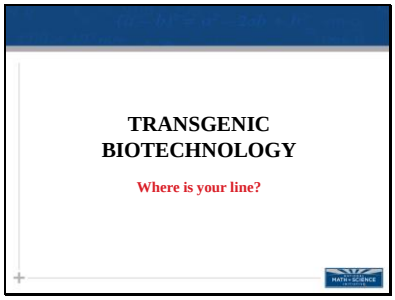
Briefly describe the four main areas of biotechnology.

Slide 4

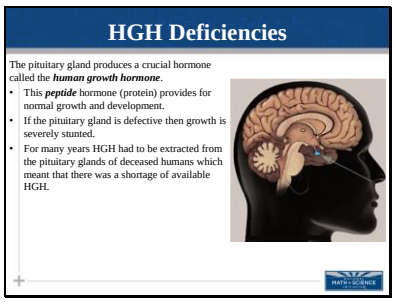


What we want to do is engage the students in a conversation/discussion over where their line is regarding bioethics and biotechnology. We use this method to give them a reason to learn more about the content in this unit. They need to know that decisions that are made regarding biotechnology are shaping the global marketplace even as they are learning this material. Give them the opportunity to speak their opinion as long as there is no judgment. The ultimate goal here is to have students think about their own opinion, listen to the opinions of others, and hopefully…decide whether their "line" has moved by the end of the lesson.

Slide 5



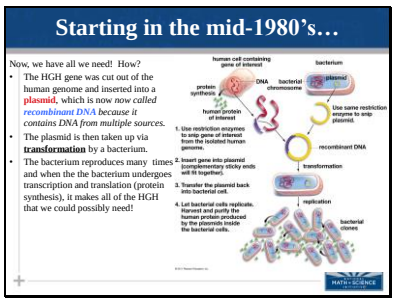
Slide 6



You could probably review the pituitary gland, the hormones it produces, and their effects by asking what other issues a defective pituitary gland might have.

- Posterior pituitary
    - Oxytocin – stimulates growth and metabolic functions
    - Antidiuretic hormone – promotes water retention in the kidneys
- Anterior pituitary
    - Growth hormone – stimulates growth and metabolic functions
    - Prolactin – stimulates milk production
    - Follicle stimulating hormone – stimulates production of ova and sperm
    - Luteinizing hormone – simulates ovaries and testes
    - Thyroid-stimulating hormone – stimulates the thyroid gland
    - Adrenocorticotropic hormone – stimulates the adrenal cortex to secrete glucocorticoids

Slide 7



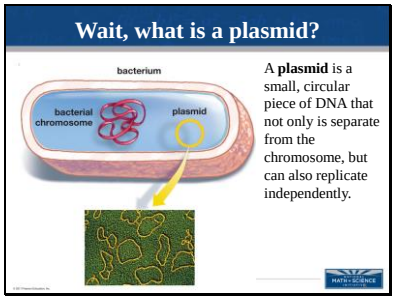
This slide shows the students how **transgenic** bacteria are made. Go through the process with them and make sure that they fully understand the following concepts before going on:

- Recombinant DNA and how it is made
- Where does the plasmid come from?
- What is transformation and what role is it playing in this process?
- We can make "proteins" with this method as the bacteria are undergoing the same process that our cells do, i.e. transcription, translation, etc.

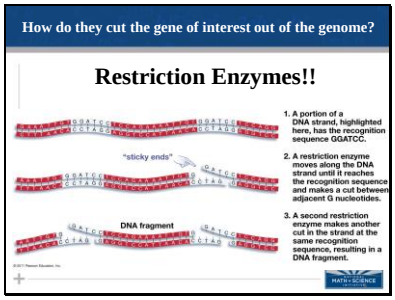
You might stop here and ask, "Does this cross anyone's line?"

Remember that the students do NOT have to memorize or learn each individual step. The main thing they need to know for the AP Biology Exam is to be able to use this as an illustrative example of genetic engineering techniques that can be used to manipulate the heritable information of DNA, and in some cases, RNA.

Slide 8



Slide 9



Go over the process with the students. Make sure that you point out how "sticky ends" are made and what makes them "sticky", i.e. their ends are complementary to other strands that have been cut with the same restriction enzyme.

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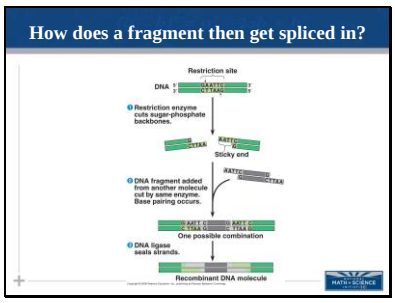
Slide 10



Go over the process with them and explain how fragments without "sticky ends" are not able to be spliced in. Go back over DNA ligase. Where have they seen that before? (DNA replication)

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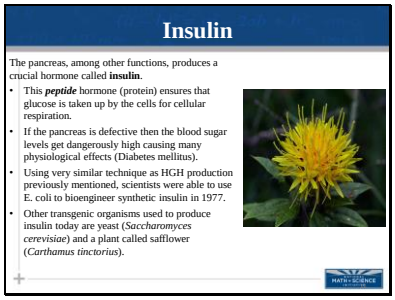
Slide 11



Go over what insulin does, where its made, and what diabetes is. Engage them in a discussion of the different ways in which it can be made synthetically.

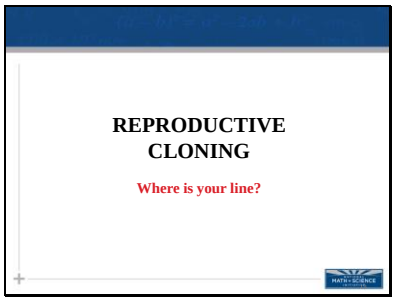
Make sure that you engage the students in a brief discussion of "Does this cross your line?" Again, this could be done by a show of hands and anyone raising their hands can give a brief explanation of why.

Slide 12

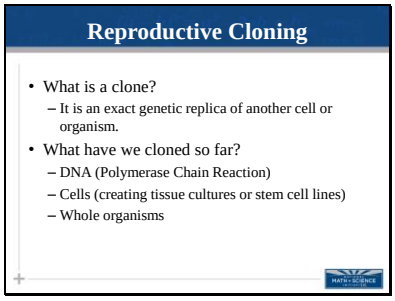
Go over what golden rice is, how its made, and what possible good it might could do. Make sure they know that because of issue with regulation, it is not "currently" being used. Much like several other GMF (Franken foods) available today.

Make sure that you engage the students in a brief discussion of "Does this cross your line?" Again, this could be done by a show of hands and anyone raising their hands can give a brief explanation of why.

Slide 13



Slide 14



You might start by asking what the students "think" cloning is and what they feel about it.

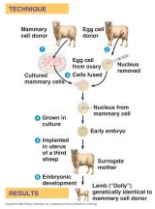
Slide 15

Organismal Cloning

- What has been cloned thus far?
  - Plants have been cloned for thousands of years!
    - Bananas, potatoes, grape vines (grafting), etc.
    - Many trees, shrubs, and vines are just clonal colonies.
  - Animals
    - Parthenogenesis – asexual reproduction that occurs naturally where offspring is born with sexual reproduction (sharks, anteaters, some insects, etc.)
    - Some animals have undergone somatic cell nuclear transfer such as: sheep, rats, cats, goats, dogs, camels, and many others.

Slide 16

Somatic Cell Nuclear Transfer (SCNT)



Go over the process of cloning outlined by the figure. Engage the students in discussion by asking the following questions:

- Is a male needed for this process? Why or why not?
- Why is an egg cell used?
- What is the difference between the DNA in the egg and the DNA in the somatic cell?

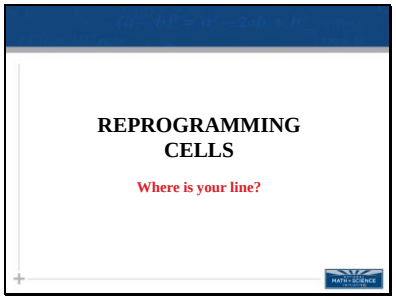
Make sure that you engage the students in a brief discussion of "Does this cross your line?" Again, this could be done by a show of hands and anyone raising their hands can give a brief explanation of why.

Remember that the students do NOT have to memorize or learn each individual step. The main thing they need to know for the AP Biology Exam is to be able to use this as an illustrative example of genetic engineering techniques that can be used to manipulate the heritable information of DNA, and in some cases, RNA.

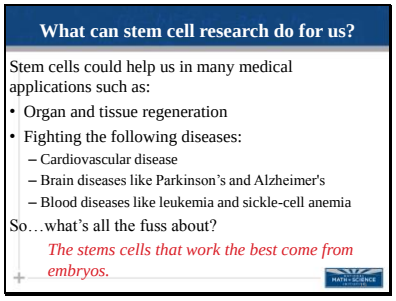
Slide 17

Make sure that you engage the students in a brief discussion of "Does this cross your line?" Again, this could be done by a show of hands and anyone raising their hands can give a brief explanation of why.

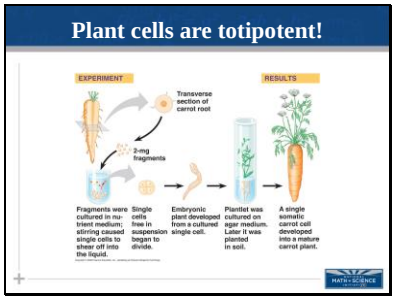
Slide 18



Slide 19

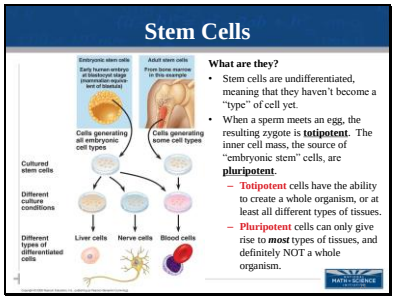


Slide 20



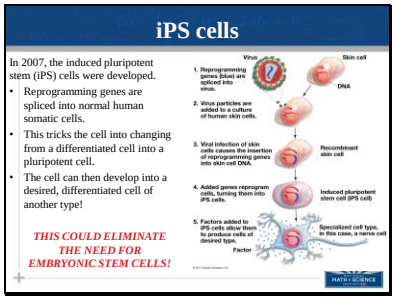
Explain how a plant, such as this carrot, can be fragmented and then used to produce a whole carrot again. Ask the students if they have ever heard of the word **totipotent** and ask them what they think it means.

Slide 21



Make sure the students understand the difference between a pluripotent cell and a totipotent cell.

Slide 22



Really engage the students and ask if iPS cells were used instead of embryonic stem cells…would they be for their use to help cure/fight diseases?

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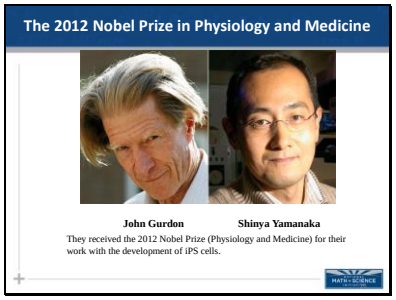
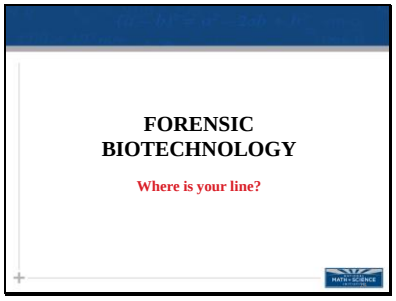
Slide 23

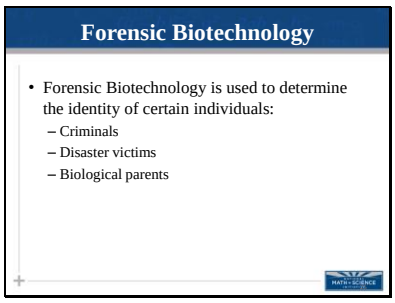


This slides stresses that the concepts and technologies discussed in this lesson are changing rapidly everyday.

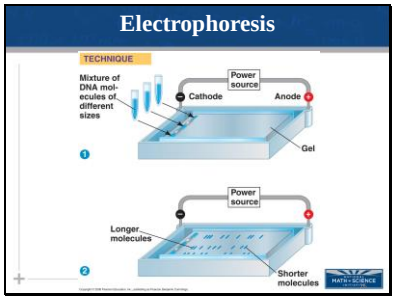
Slide 24



Slide 25



Slide 26



Engage the students in a discussion of this process by asking them the following questions:

- Why is the DNA being placed on the negative side?
- Why does it travel toward the positive side?
- Explain that the gel is like a matrix of tunnels, some large and some small. Ask: Why are the large molecules closer to the start than the smaller ones? How can we use this to identify certain fragments.
- One way to analyze a sample of DNA via electrophoresis involves cutting the sample with restriction enzymes. This requires a large sample of DNA, such as from a test tube of blood. Cutting with the enzymes will produce fragments of DNA. The length of those fragments will differ between individuals. Those differences are called **restriction fragment length polymorphisms (RFLP).** The illustration in this slide and the next could be RFLPs. How can this be used to do paternity tests or crime scene analysis? (compare banding patterns between samples)

Make sure that you engage the students in a brief discussion of "Does this cross your line?" Again, this could be done by a show of hands and anyone raising his or her hands can give a brief explanation of why.

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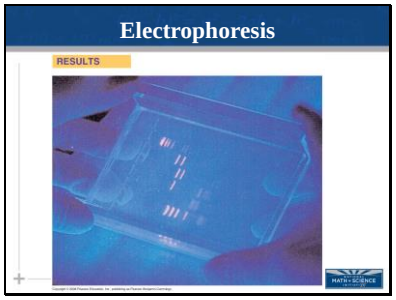
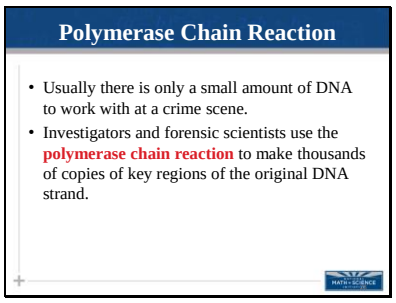
Slide 27

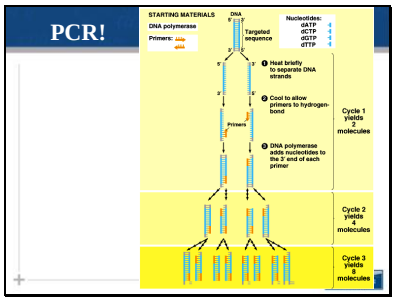


Slide 28



The small amount of sample available at most crime scenes makes RFLP analysis impossible. Another option is to use PCR to produce products to analyze in other ways, as described in the following slides. Note that no restriction enzymes are used in analyzing PCR products, so we do not refer to RFLPs when discussing PCR analysis of DNA. If large samples of DNA are present, then both techniques could be used.

Slide 29



For a great animations showing how PCR works, see http://www.dnalc.org/view/15924-Making-many-copies-of-DNA.html and http://www.dnalc.org/view/15475-The-cycles-of-the-polymerase-chain-reaction-PCR-3D-animation-with-no-audio.html (the first is in 2D and the second is in 3D)

Take some time going over this figure and the animation(s). It is important to realize that only a relatively short (up to 20,000 base pairs, but typically much shorter than that) "target sequence" is being amplified. The area between the two primers is the target sequence. In the image on the slide, point out that the chromosome goes on for a very long distance both above and below the stretch being shown in the illustration. PCR can not be used to copy an entire chromosome. Make sure the student understands what is going on here by prompting them to explain the following:

- What is a primer used for?
- How is DNA polymerase used in this process?
- What else must be in the test tube for the process to work? (template DNA; nucleotides – A,C,G,T)

- What does heating up the test tube mixture do?
- What does cooling the test tube mixture do?

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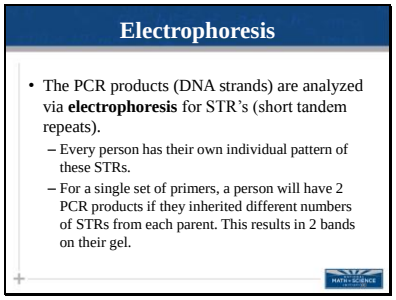
Make sure that you engage the students in a brief discussion of "Does this cross your line?" Again, this could be done by a show of hands and anyone raising his or her hands can give a brief explanation of why.

Slide 30

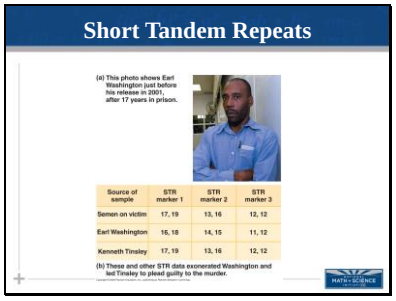


Each PCR reaction typically amplifies a single locus (there are some researchers using multiple primers in a single mixture, but that is not important for our level of discussion). Since we all have two copies of each locus (thanks to our maternal and paternal homologous chromosomes), we will get two separate products from a single PCR reaction. If the region between the primers on our paternal chromosome differs in length from the region between those same primers on our maternal chromosome then we get products of different sizes which then show up as two separate bands on a gel. If the products happen to be the same length, then only one band results. One of the most common regions for pcr analysis are those containing short repeated segments of

DNA between the primer sites. These are called STRs. One might have 15 repeats of that sequence between the primer sites on the paternal chromosome and 18 repeats of that same sequence between the same primer sites on the maternal chromosome. This would then result in two bands on a gel when these PCR products are analyzed. By using multiple sets of primers, one can get numerous bands to compare between samples.

Numerous other differences could be analyzed other than STRs, such as SNPs (single nucleotide polymorphisms), etc. but students do not need to know every possible method of analyzing DNA differences. They DO need to know that differences exist and why they exist.

Slide 31

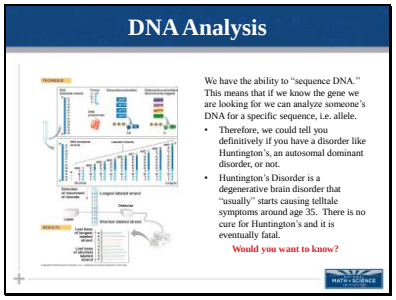


Earl Washington, Jr. was sentenced in 1982 for rape and murder. In 1994, DNA from the crime scene was tested and in the analysis of the DNA on the victim and the two suspect, it was found that Mr. Washington was NOT guilty. Shortly before his execution the governor of Virginia gave him clemency and commuted his sentence to life in prison. Years later he was given a full pardon and released from prison…after 17 years.

In the table, the numbers refer to the number of repeats at each locus. For instance, at locus 1 (STR marker 1), Earl had 16 repeats on one of his chromosomes and 18 on the other. The evidence DNA had 17 and 19 repeats, meaning it could not have come from Earl. But it did match Kenneth Tinsley. Note that STR marker 1 was enough to

eliminate Earl as a suspect, but that single site would not be conclusive as to it coming from Kenneth. Numerous sites were used and all matched Kenneth Tinsley.

Slide 32



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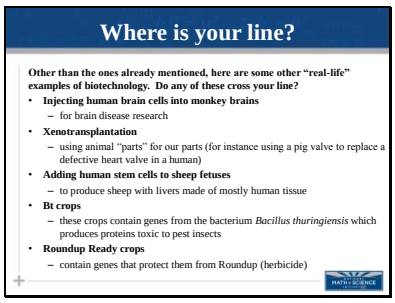
Slide 33



Again, the goal is to get students to find their "line" and ask themselves why their line is where it is and most importantly…what circumstances could make my line change.

Slide 34