

Biotechnology Notes

Applying science knowledge and new technology to our 21st century needs

1950s

- Scientists had concluded that DNA is the genetic material
- But...
 - The field of _____ was just beginning
 - The field of Biotechnology did not yet exist!!

Nucleotides > Genes > Chromosomes

- Researchers must be able to work with _____ without being able to see it or handle it directly
 - It's too _____!
- A whole _____ is still too large to study all at once, there's just too much _____

One of the first things to consider in biotechnology and genetics research is how to _____ cut DNA

Human DNA is approximately _____ base pairs long, and we have about _____ different _____.

In order to study a specific gene we need to cut down the long strand of DNA and select only the specific gene or region that we are working on

_____ = "molecular scissors"

Bacteria are the factory workers of Biotech

- Bacteria can be _____ by _____, as a defense mechanism they produce _____ Enzymes to cut up the foreign DNA of the virus.
- Restriction Enzymes only cut a strand of _____ at a _____ sequence called a _____ or recognition site.
- There are _____ of known restriction enzymes
- Restriction sites are _____ - _____ base pairs long.

Restriction Enzyme & DNA Ligase

- **Restriction enzyme (blue):** cuts DNA---leaves " _____ "
- **DNA _____ (green):** " _____ " DNA back together

Cuts can be 'blunt' or 'sticky'

ACTGGTACGAATTCCGTA

1. Put a box around the recognition site

TGACCATCCTTAAGGCAT

2. Draw a line where the restriction enzymes cuts the DNA.

Once DNA has been cut into fragments by restriction enzymes, the fragments can be _____ or separated by _____

Gel Electrophoresis

- An _____ current is used to separate a mixture of different fragments of DNA
- Because DNA has a _____ charge, the fragments move toward the _____ electrode
- Pores in the gel allow _____ molecules to move through the gel _____, while large molecules get “_____” and move slowly
- So, the _____ of a DNA fragment can be estimated _____ to other fragments by measuring how far each fragment migrated through the gel
- DNA fragments appear as different _____ or lines on the gel (after staining)

Restriction Maps

- The band pattern can be thought of as a _____ of the original strand of DNA
- The map shows the lengths of DNA fragments between restriction sites on a DNA strand

How can we get a large enough sample of DNA to work with?

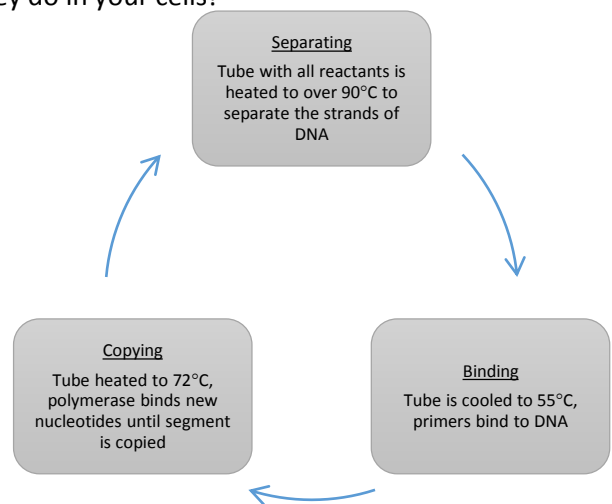
- _____ (PCR)

Polymerase Chain Reaction (PCR)

- A technique that produces _____ (or billions!) of copies of a specific DNA sequence in hours
- Invented by Kary Mullis in 1983
 - He patented the process and sold the rights for \$300 million
 - Won the Nobel Prize in Chemistry in 1993
- Under the right set of conditions, _____ enzymes will make new copies of DNA in a test tube, just like they do in your cells!

4 Starting Materials:

-
-
-
-



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- Each PCR cycle _____ the number of DNA copies
- $1 > 2 > 4 > 8 > 16 > 32 > 64 > 128 > 256 > 512 \dots$
- After 30 cycles, more than 1 _____ copies!
- What is a _____? A short segment of DNA that acts as a _____
_____ for the new strand

DNA Fingerprinting – a restriction map!

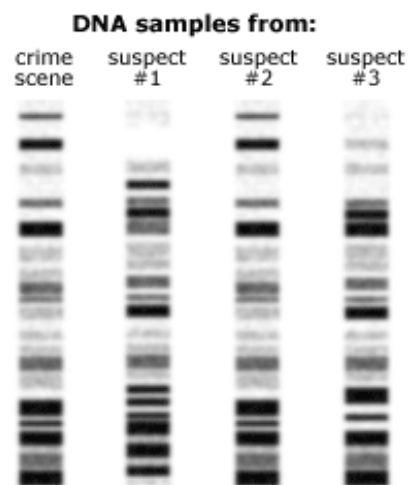
- A _____ of parts of an individual's DNA that can be used to identify a person at the molecular level
- A DNA sample is cut with _____ enzymes and a restriction map is created on a _____
 - When _____ DNA samples are treated with the same restriction enzymes, their fragments can be compared _____ on the same gel
 - Since our DNA sequence can't change, the restriction map for 1 person will always be the _____ when treated with the same _____

Our DNA is 99.9% identical, how do we find the differences?

- The greatest differences in DNA sequence between people are in the _____
_____ sections of our DNA (introns)
- So....DNA fingerprinting focused on the _____, which often include stretches of nucleotide sequences that _____ several times
- Each person's _____ differs in how many _____ they have
- DNA fingerprinting has become reliable and widely used in US courts since the 1990s
- In most _____ cases, at least _____ regions of DNA are analyzed
- This technique can be used to:

-
-
-

- Side by side comparison of _____ profiles



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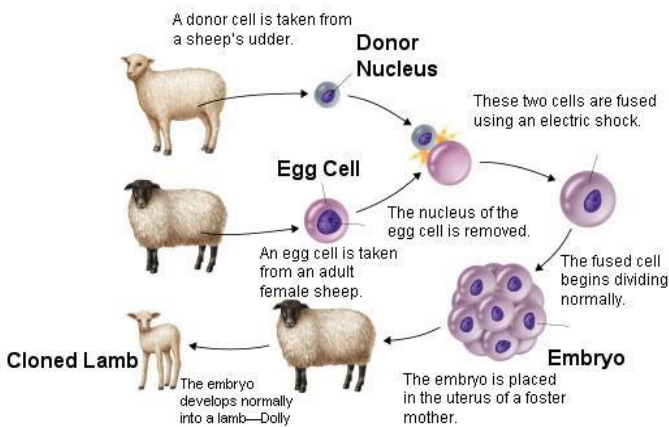
Genetic Engineering – changing DNA!

- Clone – _____
- Uses:
 -
 -
 -

Hello Dolly is _____

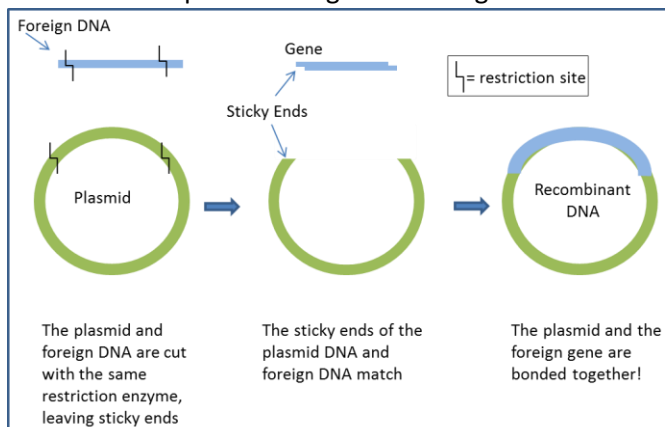
- Created through _____

How Dolly?



Recombinant DNA

- Contains genes from more than 1 organism
- _____ – tiny _____ of DNA, found in bacteria, that separate from the bacterial chromosome and _____ on their own
- Bacteria will replicate foreign DNA along with their own!



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Bacterial Transformation

- Bacteria are turned into gene factories when _____ containing specific _____ are put into the bacteria
- The bacteria will:
 -
 -
- We call these bacteria “transformed” cells

Transgenic Organism

- Contain one or more _____ from another organism
- In plants, transgenic bacteria _____ the plant, the new gene becomes part of the plant’s _____
- Example:
 -
 -
 -

Genetically Modified Organisms

- An organism whose DNA has been altered using genetic engineering technology

Benefits to GMO Food

- * _____ *
- * _____ *
- * _____ *

Benefits to GMO Animals

- * _____ * _____ *

Controversies Against GMOs

- * _____ *
- * _____ *

Genomics

- The study of _____, which can include the sequencing of all of an organism’s _____

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- Scientists can compare genomes both _____ and across species to find similarities and differences
 - Find genes that cause _____
 - _____ relationships
 - Gene sequencing – determining the order of DNA _____ (DNA sequence) of genes or genomes

Human Genome Project – 1990s

Goals:

1. Map and sequence all of the DNA base pairs of the human chromosomes
 - a. _____
 - b. _____
2. Identify all of the genes within the sequence

Genetic Screening and Gene Therapy

- _____ – testing DNA to determine a person's _____ of having or passing on a genetic disorder
- _____ – replacement of a _____ or _____ gene, or addition of a new gene, into a person's genome

Mostly Experimental!

Gene Therapy

- The introduction of _____ into cells to compensate for _____ genes or to make a beneficial _____.
- If a _____ gene causes a necessary protein to be faulty or missing, gene therapy may be able to introduce a _____ copy of the gene to restore the function of the _____.

Gene Therapy Examples

Severe Combined Immunodeficiency (SCID)

- Absence of functional _____ system
- “Bubble boy disease”

Cystic Fibrosis

- Defective _____ gene
- Deletion of three nucleotides

