

The California Condor:
Recovering a species from the brink of extinction



The California Condor

- *Listed as endangered in 1967*
 - *Habitat Destruction*
 - *Poaching*
 - *Lead Poisoning*



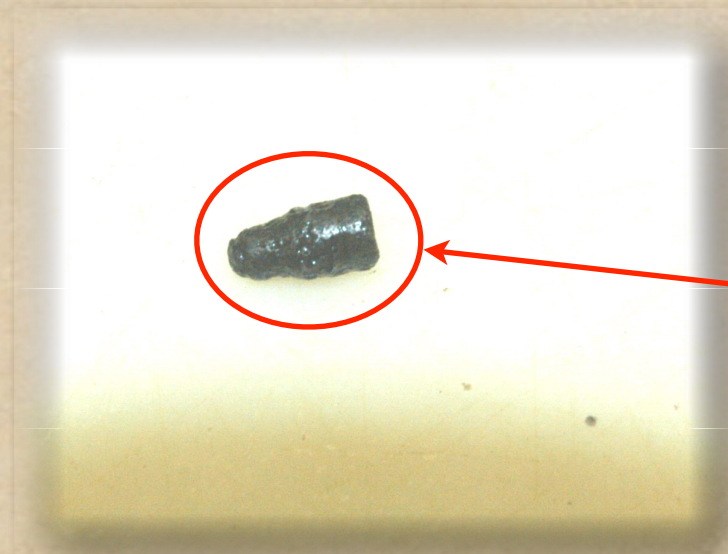
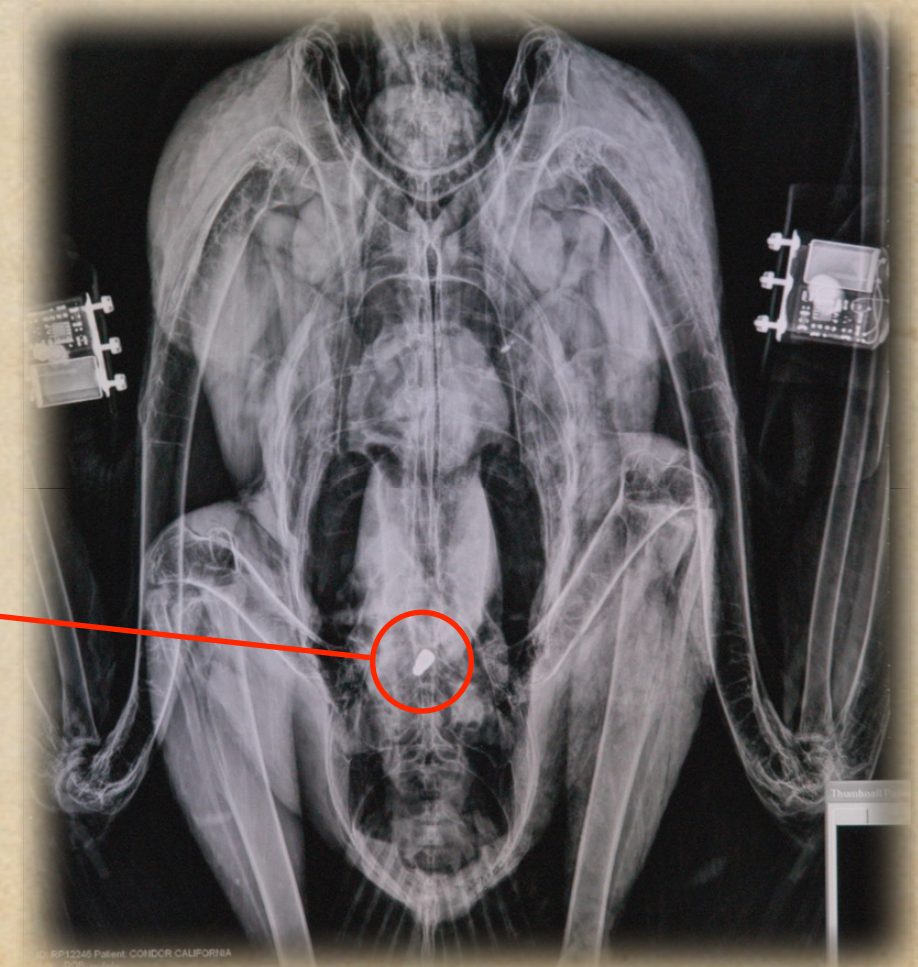
Recovery Efforts

- By 1987 there were less than 25 condors*
- But, our recovery efforts are working*
- Now more than 400 condors on Earth*
- California, Arizona, and Mexico*
- San Diego Zoo and Safari Park*



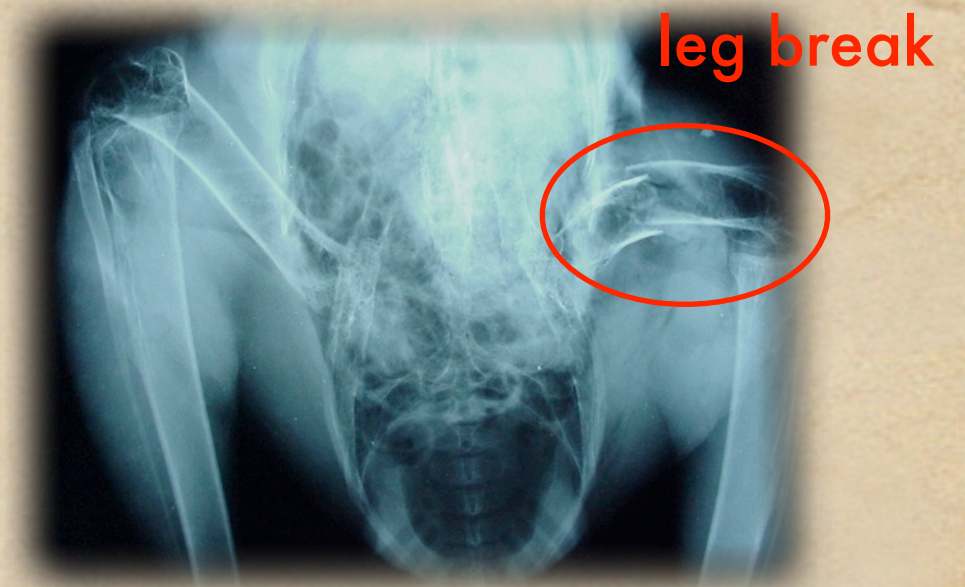
Human Issues

- *Condors are scavengers*
- *Lead bullets in carcasses*
- *Lead poisoning*
- *Lead cannot be metabolized*
- *Impacts enzyme function*
- *Laws are changing!*

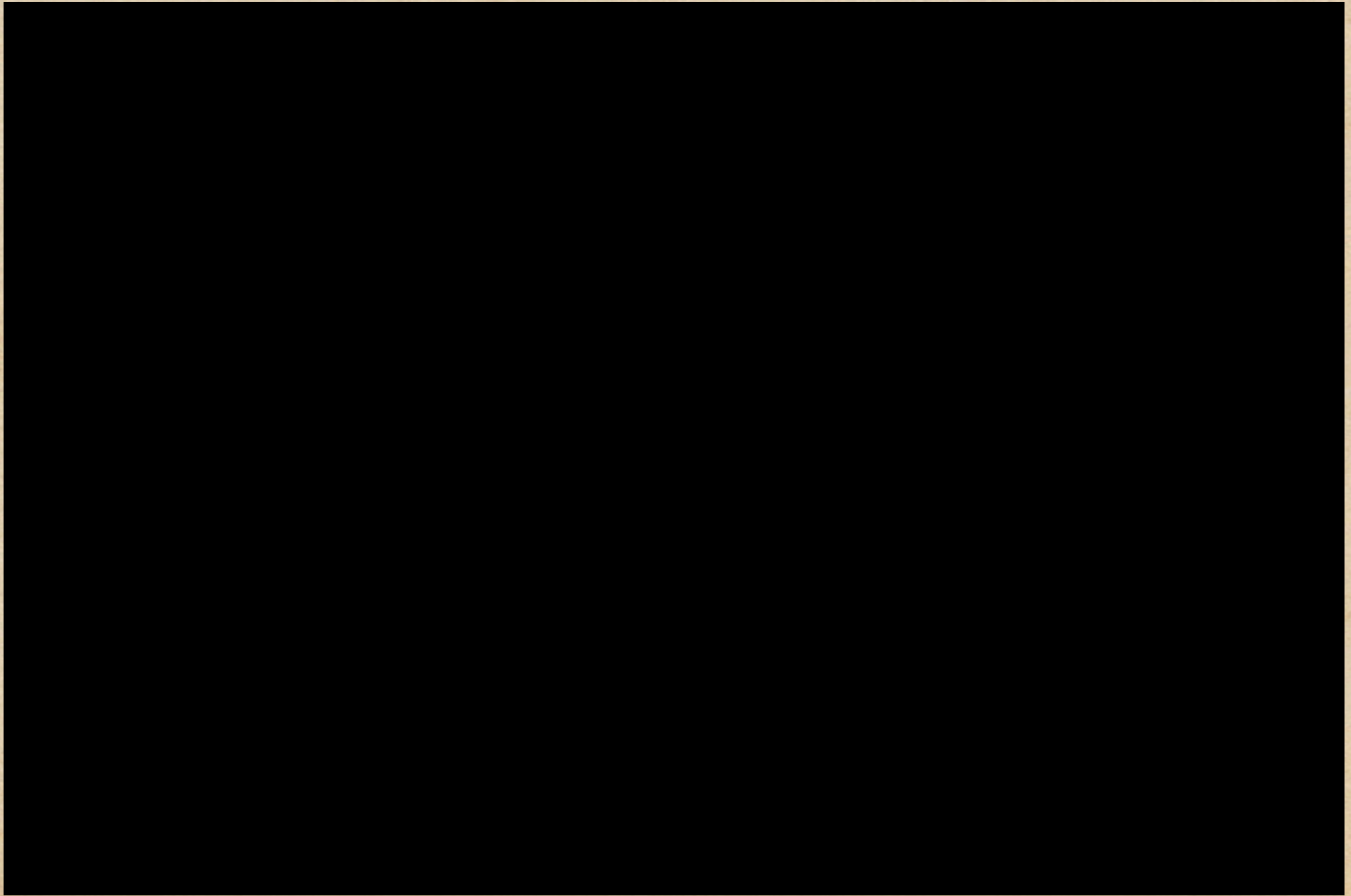


Human Issues

- *Power line collisions*
- *Killed on impact*
- *Electrocution*
- *Aversion therapy*

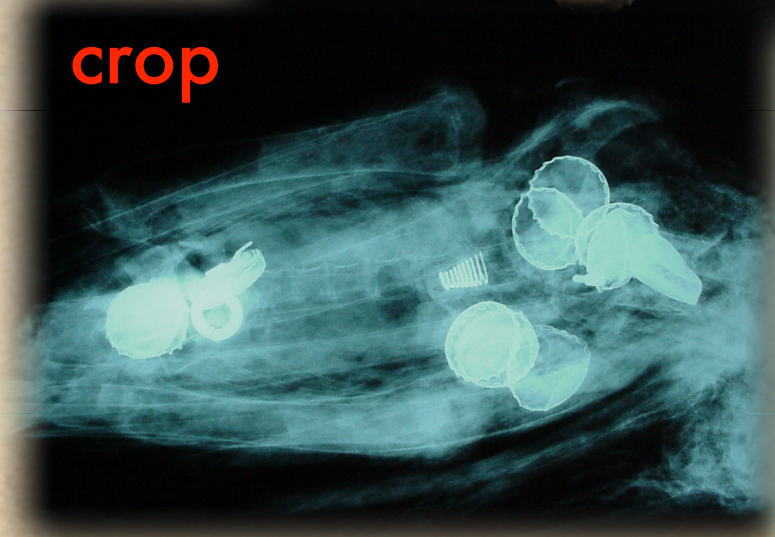


Aversion Therapy



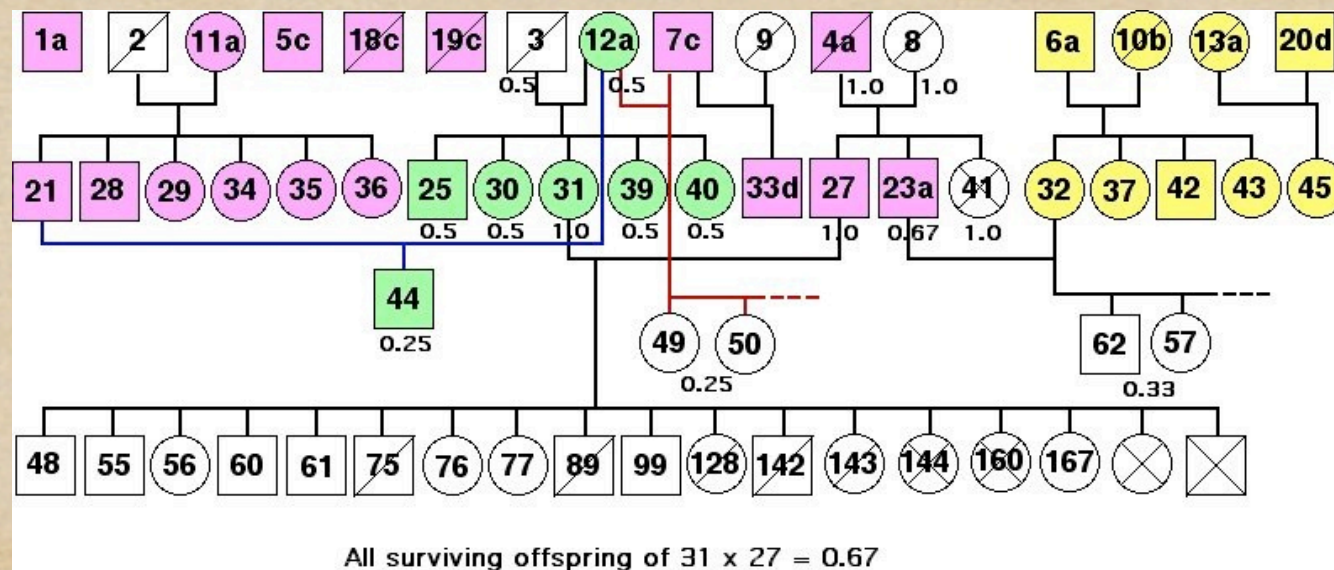
Behavioral Issues

- *Odd parental behavior (“microtrash”)*
- *Released birds only*
- *Causes sickness and/or death*



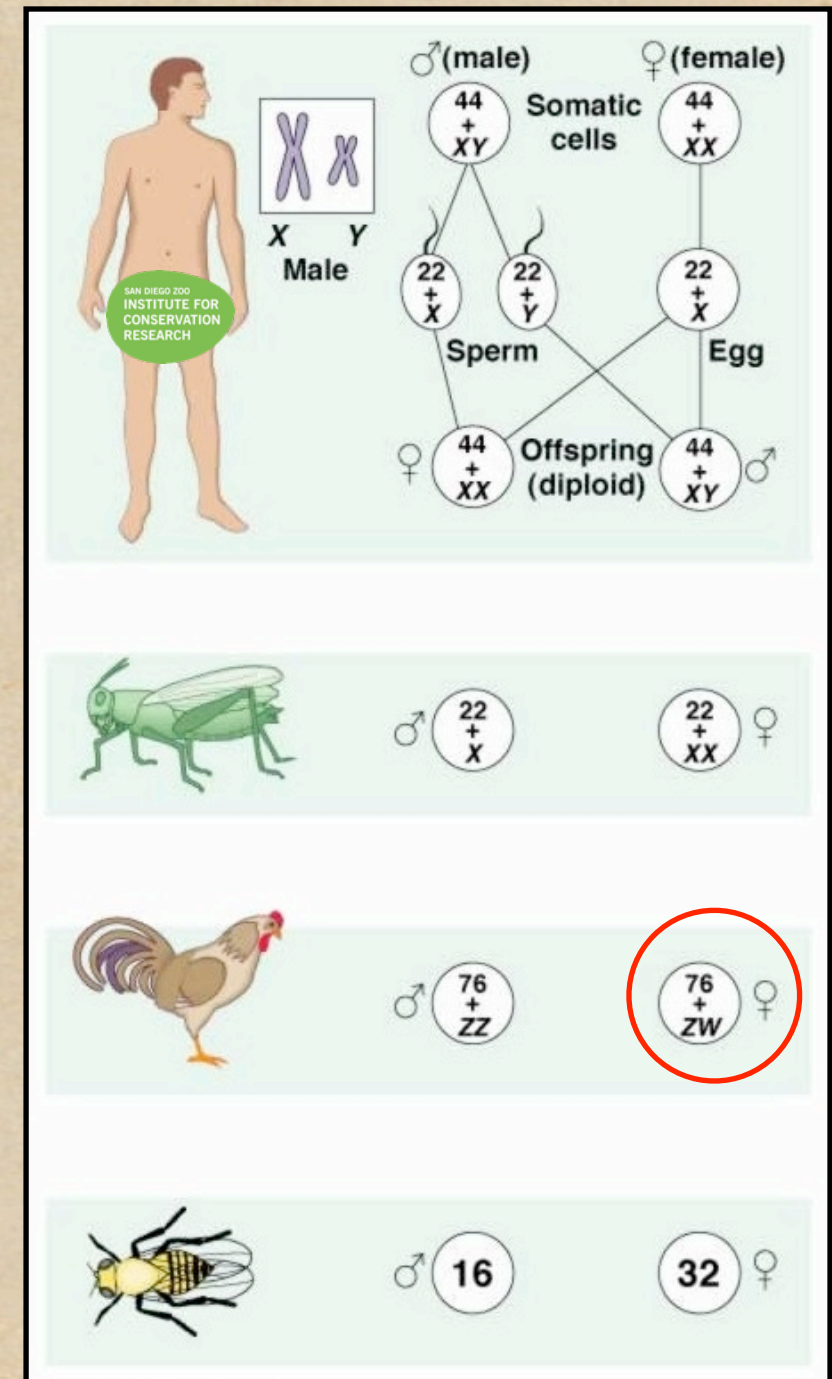
Genetic Issues

- *Chondrodystrophy*
- *Autosomal recessive allele*
- *Causes lethal dwarfism*
- *Occurs in 10% of condor population*
- *Requires strict management strategies*



Gender Determination

- Males and females look physically identical
- Sex-specific chromosome compliment
- In birds, females are the heterogametic gender
- Gender is essential information for captive breeding
- Gender is determined in one of two ways



Chromosome Analysis



Male

Female

Deoxyribonucleic acid

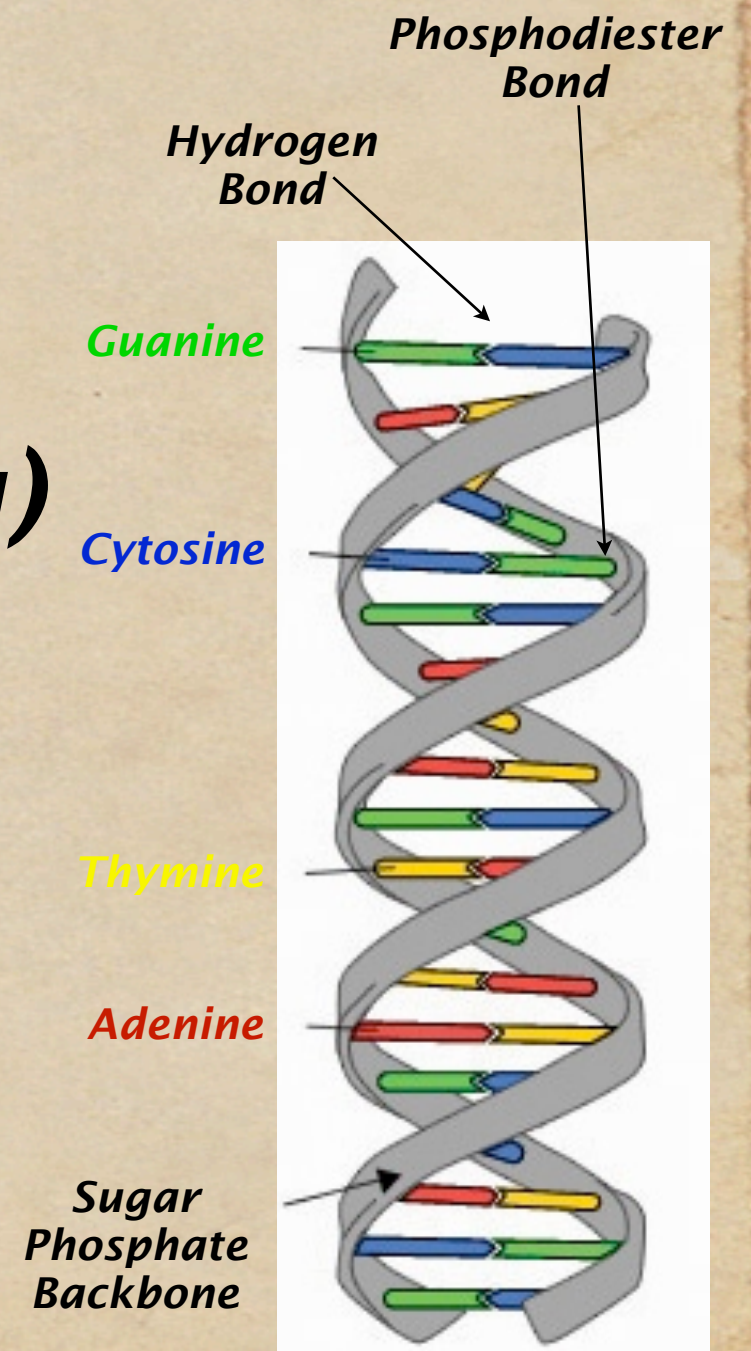
- ***“DNA” analysis***
- ***Found inside all living things***
- ***Packaged into chromosomes***
- ***Vast and informative molecule***



DNA *structure*

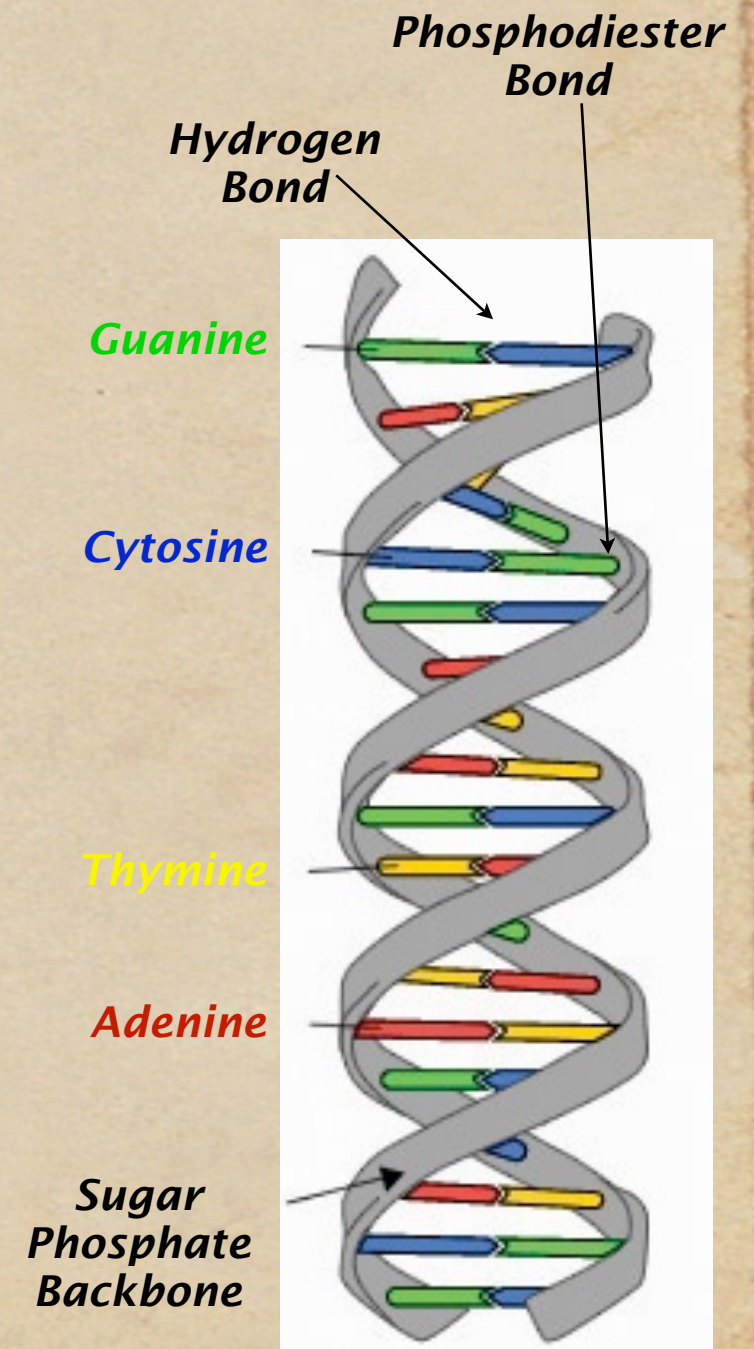
Guanine-Cytosine
Thymine-Adenine

- **Base pairs**
- **Hydrogen bonds (strong)**
- **Phosphodiester bonds (even stronger)**



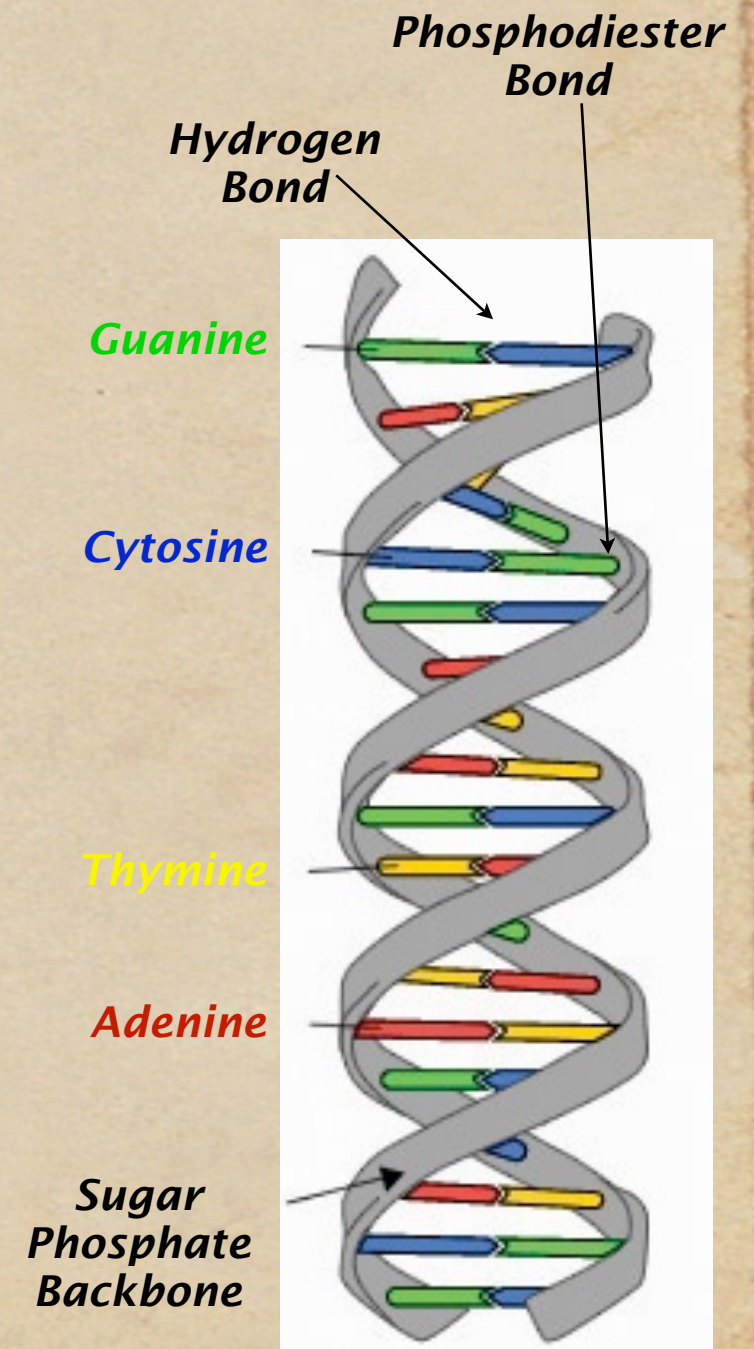
DNA function

- *Responsible for all body functions*
- *Allows us to live and grow*
- *Heredity (storage unit)*
- *Cellular metabolism*
- *Protein production*
- *Makes copies of itself*
- *Repairs itself*



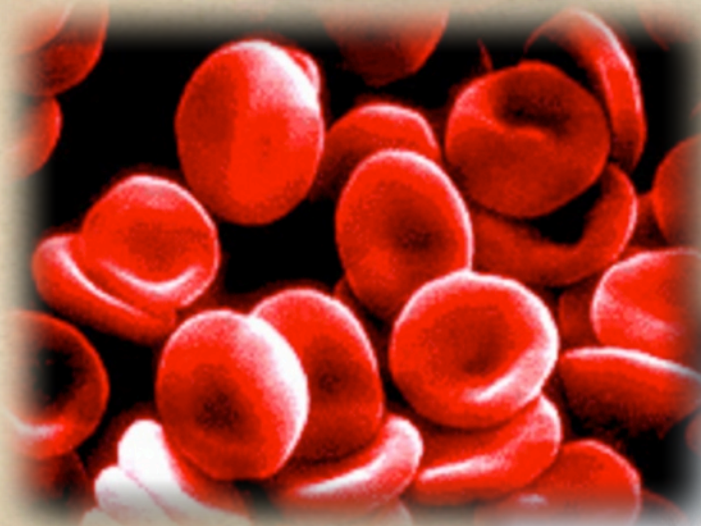
Uses of DNA

- *Genetic diversity*
- *Paternity*
- *Gene-mapping*
- *Species identification*
- *Genotyping*
- *Chromosome analysis*
- *Gender determination*



Sources of DNA

- *feather*
- *spores*
- *egg shell*
- *body tissue*
- *feces*
- *urine*
- *hair follicle*
- *blood*



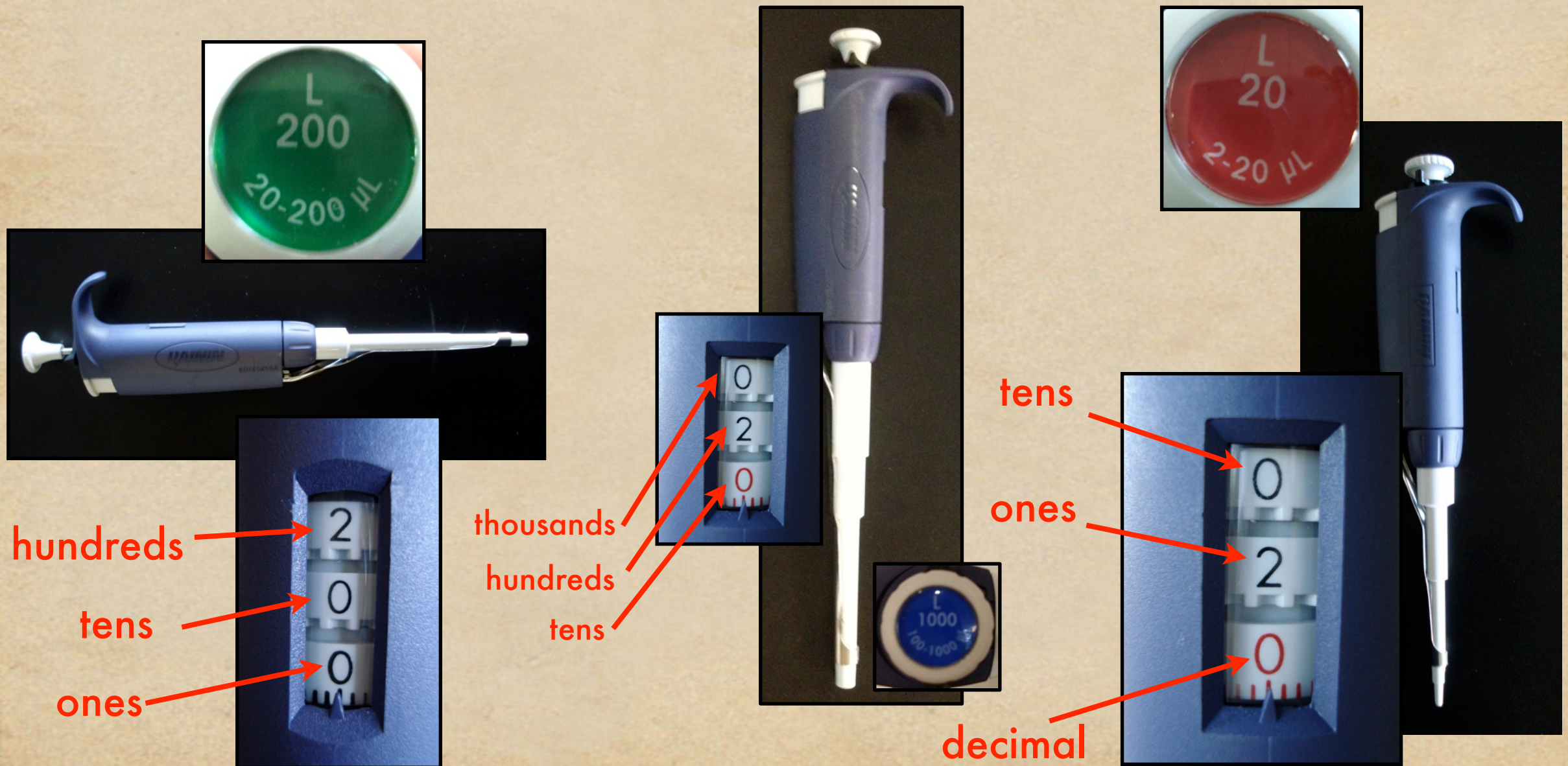
Sources of DNA

- *Decide on a source (blood)*
- *Break open cellular membrane*
- *Break open nuclear membrane*
- *Digest bound proteins*
- *Separate DNA from “junk”*
- *Qiagen protocol is fast & easy*



The art of pipetting

- *We're working with VERY small volumes*
- *liter (L), milliliter (mL), microliter (ul)*



Chromosomal Differences

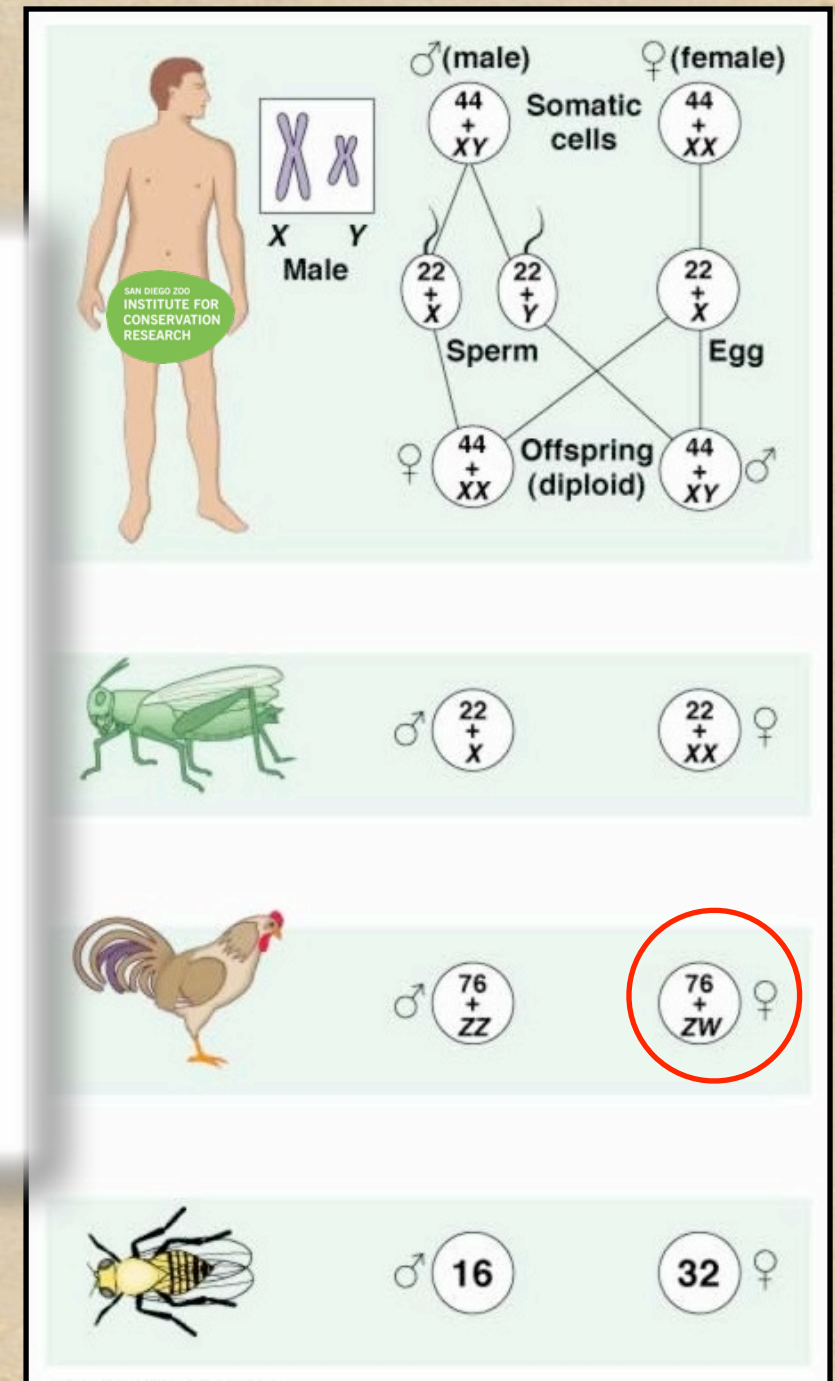
- Females have two different sex chromosomes
- Scientists have identified a gene that varies in length on the Z and W
- This gene is ~250 bases long on the Z and ~300 bases long on the W



Z Z

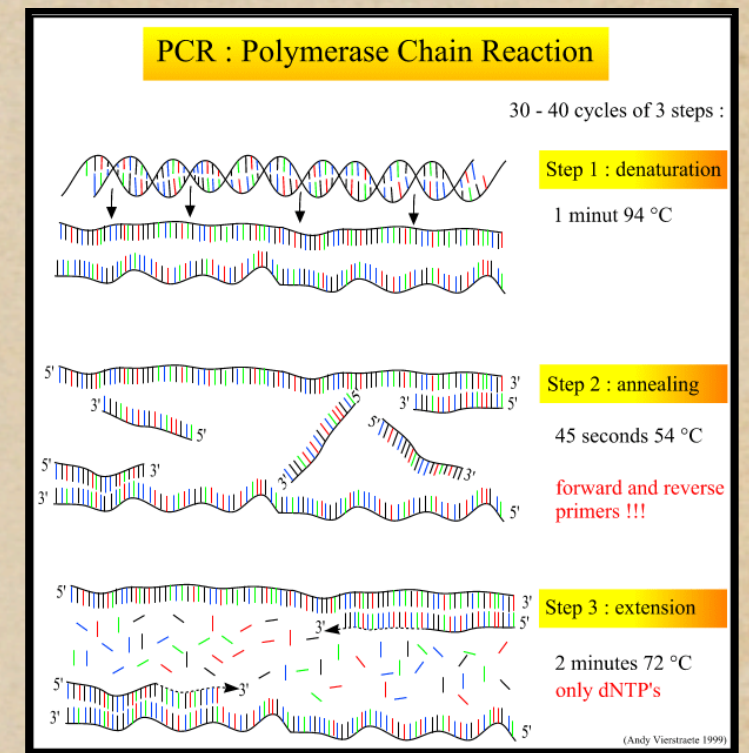


Z W



Polymerase Chain Reaction

- *A reaction used to make billions of copies of a single region of the DNA (the “target” region)*
- *Used in gender determination, genotyping, species identification, paternity, genetic diversity, gene-mapping, phylogenetics, etc.*

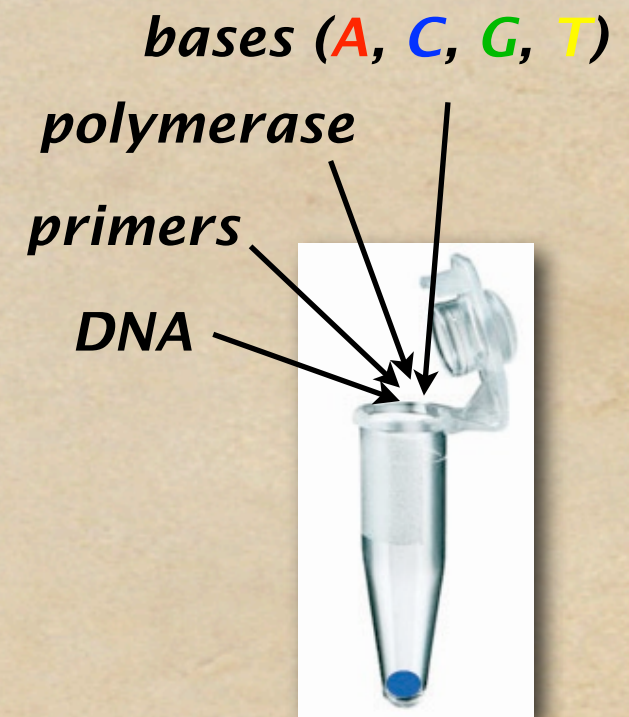
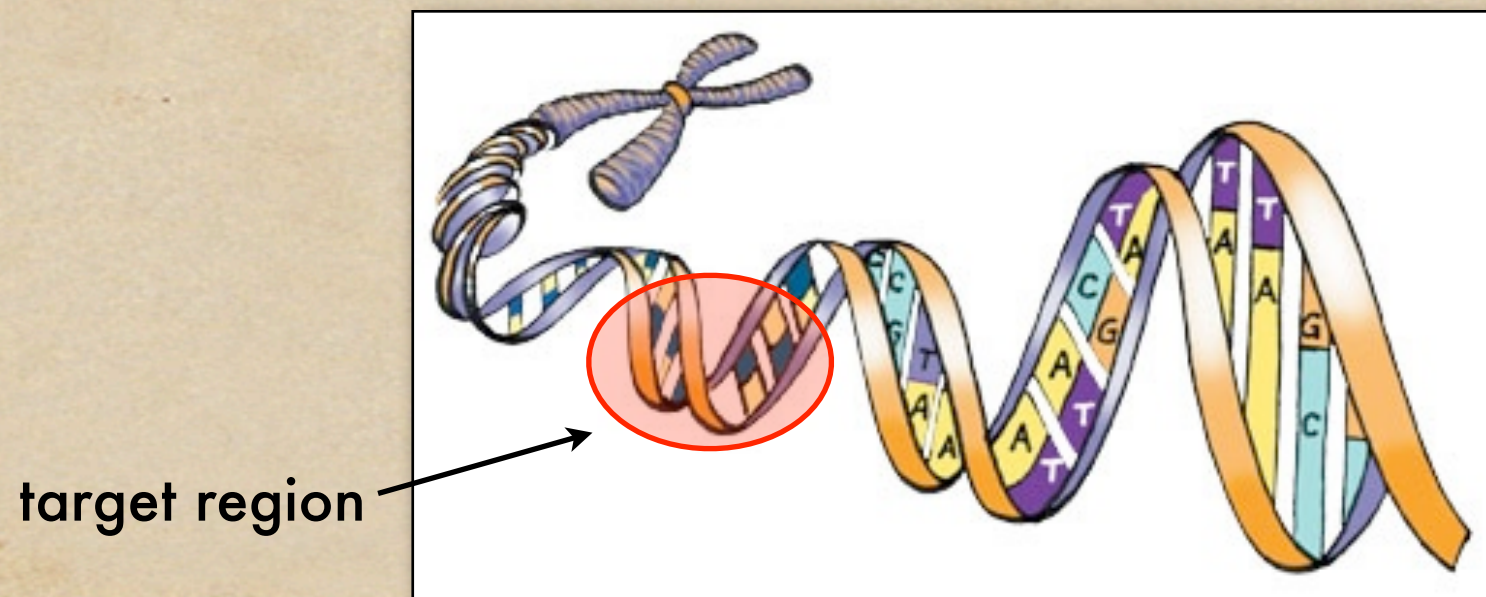


Nobel prize-winning
San Diegan!

Polymerase Chain Reaction

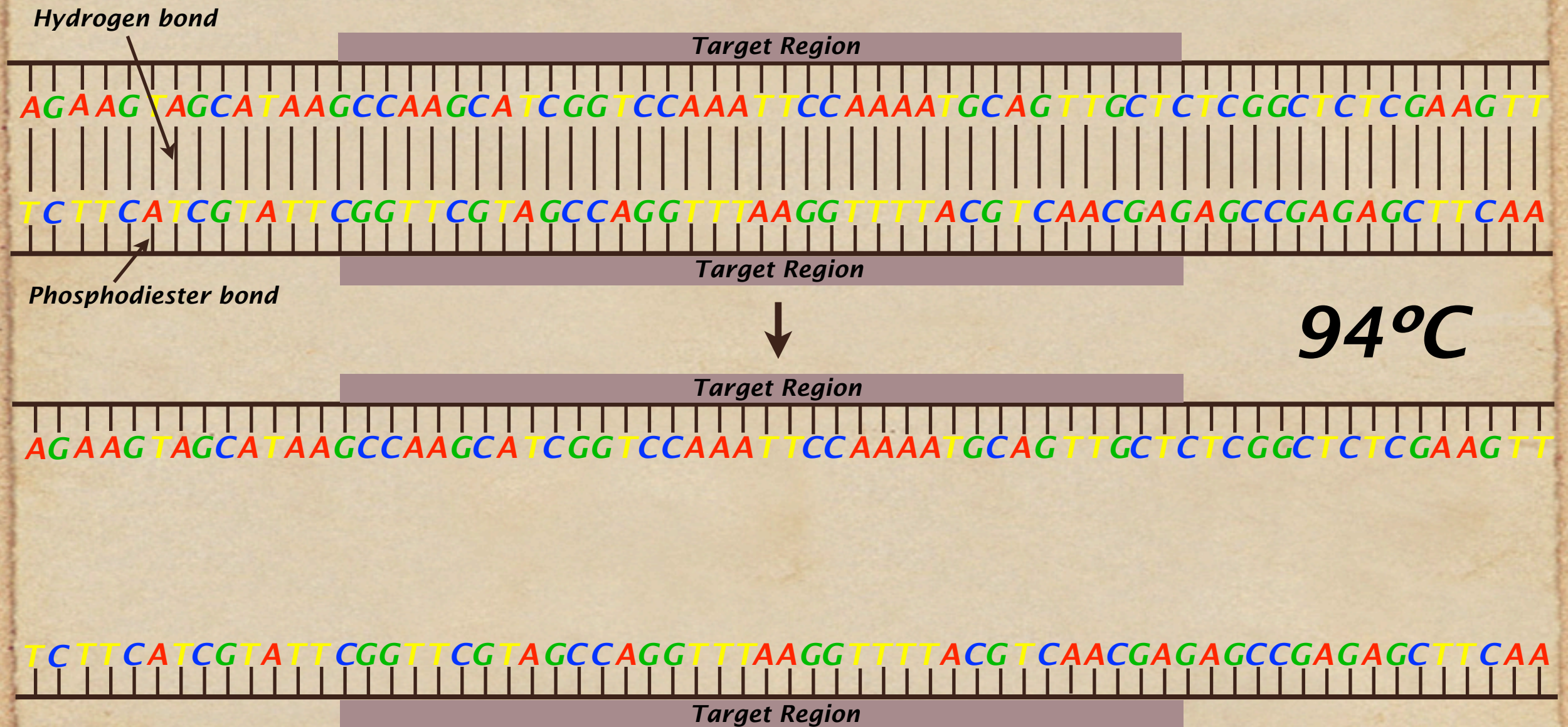
Decide which part of the DNA to study

- 1st step: Break open the DNA***
- 2nd step: Attach primers to the DNA***
- 3rd step: Build new DNA***
- 4th step: Repeat the steps!***



Polymerase Chain Reaction

1st step: Break open the DNA



Also called “Denaturing” step

Polymerase Chain Reaction

2nd step: Attach primers to the DNA



50°C

Also called “Annealing” step

Polymerase Chain Reaction

3rd step: Build new DNA



Also called “Extension” step

Polymerase Chain Reaction



AGAAGTAGCATAAAGCCAA
CGGTT

TAGCATAAAGCCAA
TCTTCATCGTATT CGGTT

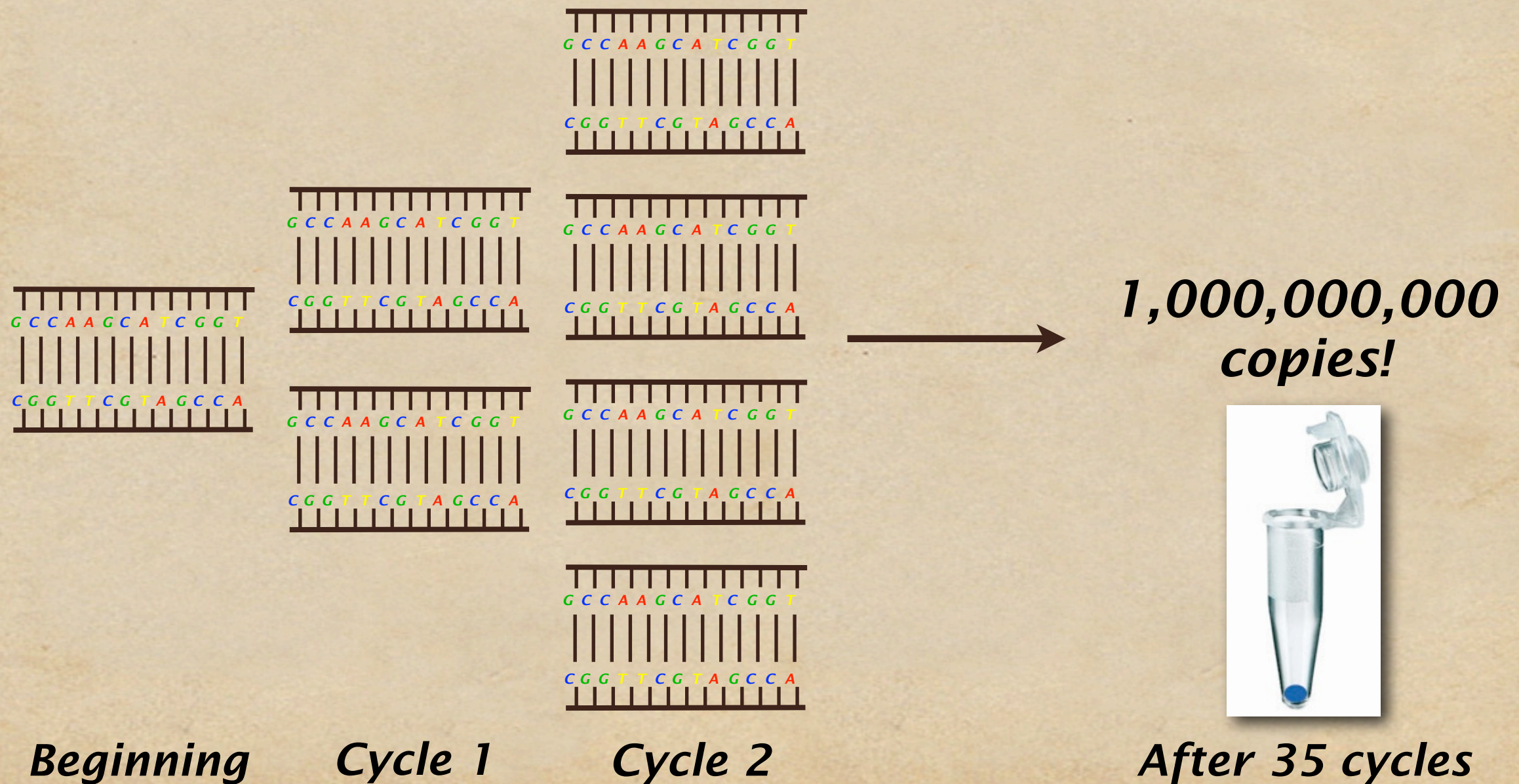
TTGCTCTCGGCTCTCGAAGTT
AACGAGAGCCGAGA

TTGCT
AACGAGAGCCGAGAGCTTCAA

Thermophilic bacterium
(*Thermus aquaticus*)

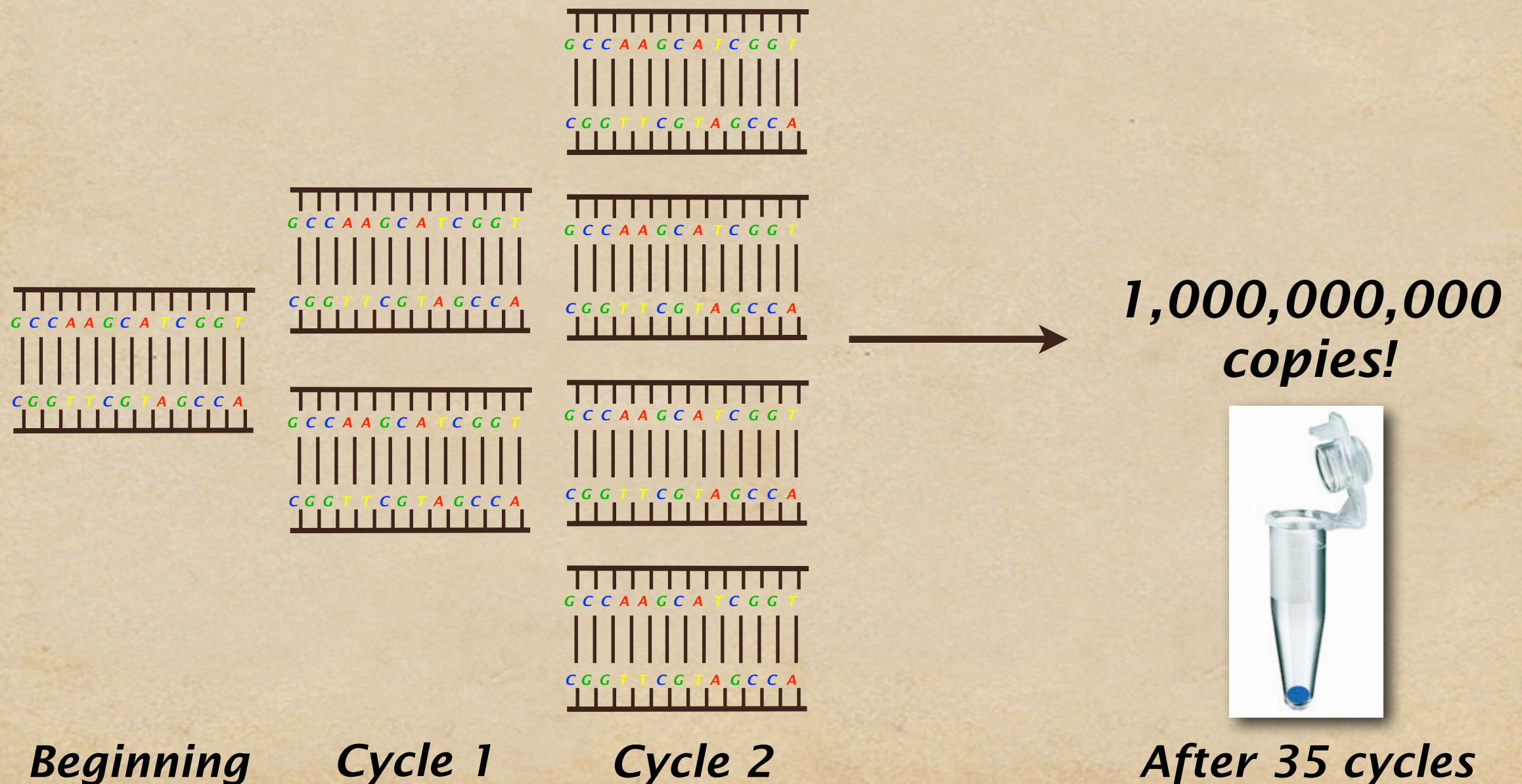
Polymerase Chain Reaction

4th step: Repeat the process several times



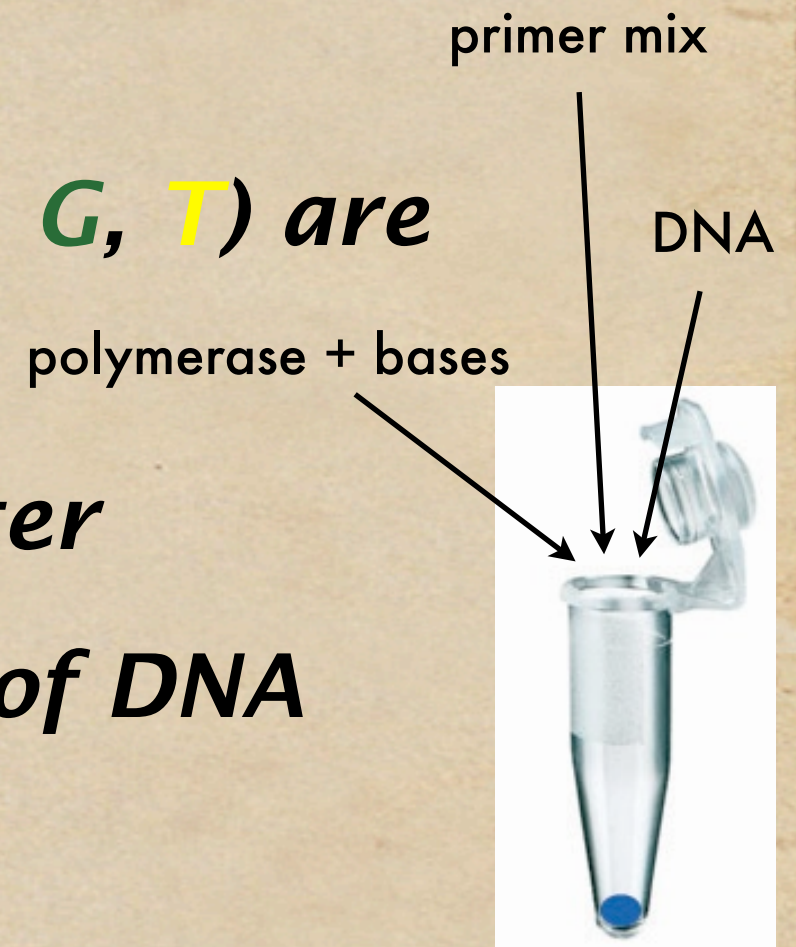
Polymerase Chain Reaction

4th step: Repeat the process several times



Polymerase Chain Reaction

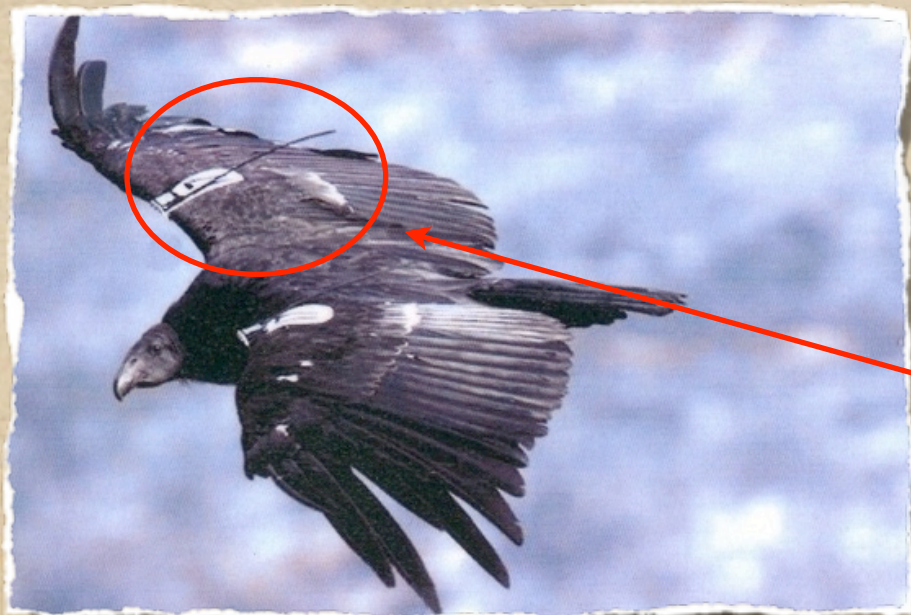
- *We're using special tubes*
- *Taq polymerase and bases (A, C, G, T) are already in the tube*
- *Primer mix = both primers + water*
- *Add 18ul of primer mix and 2ul of DNA*
- *Total volume should be 20ul*
- *Mix (vortex) and then spin down (mini-centrifuge)*
- *Put reactions in the thermalcycler!*



Radio Telemetry



antenna
receiver



radio
transmitter

Tracking Condors in the Wild



Gel Electrophoresis

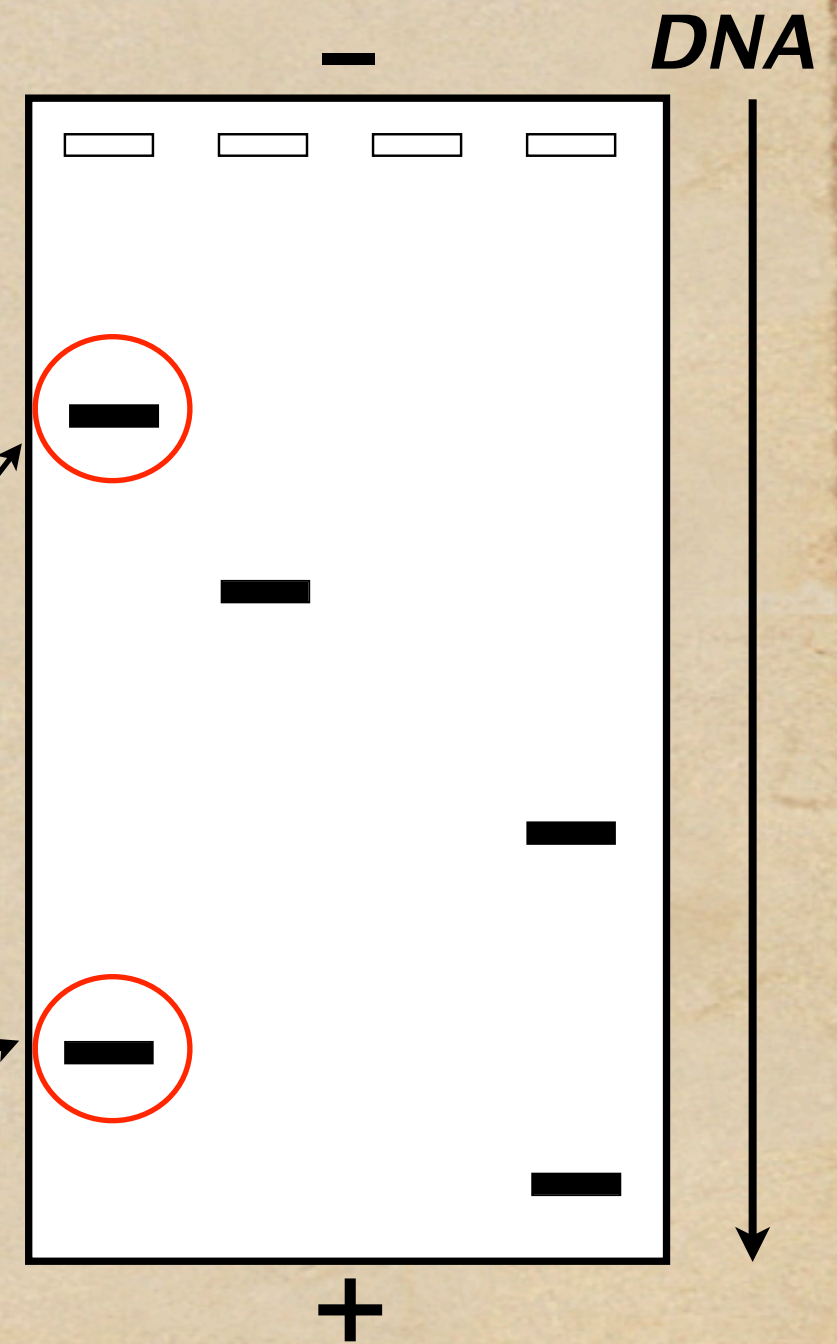
- ***Used to visualize size and presence of PCR products (pieces of DNA)***
- ***Sorts DNA fragments by size***
- ***DNA has a slight negative charge***
- ***Large pieces move more slowly***
- ***Small pieces move more quickly***



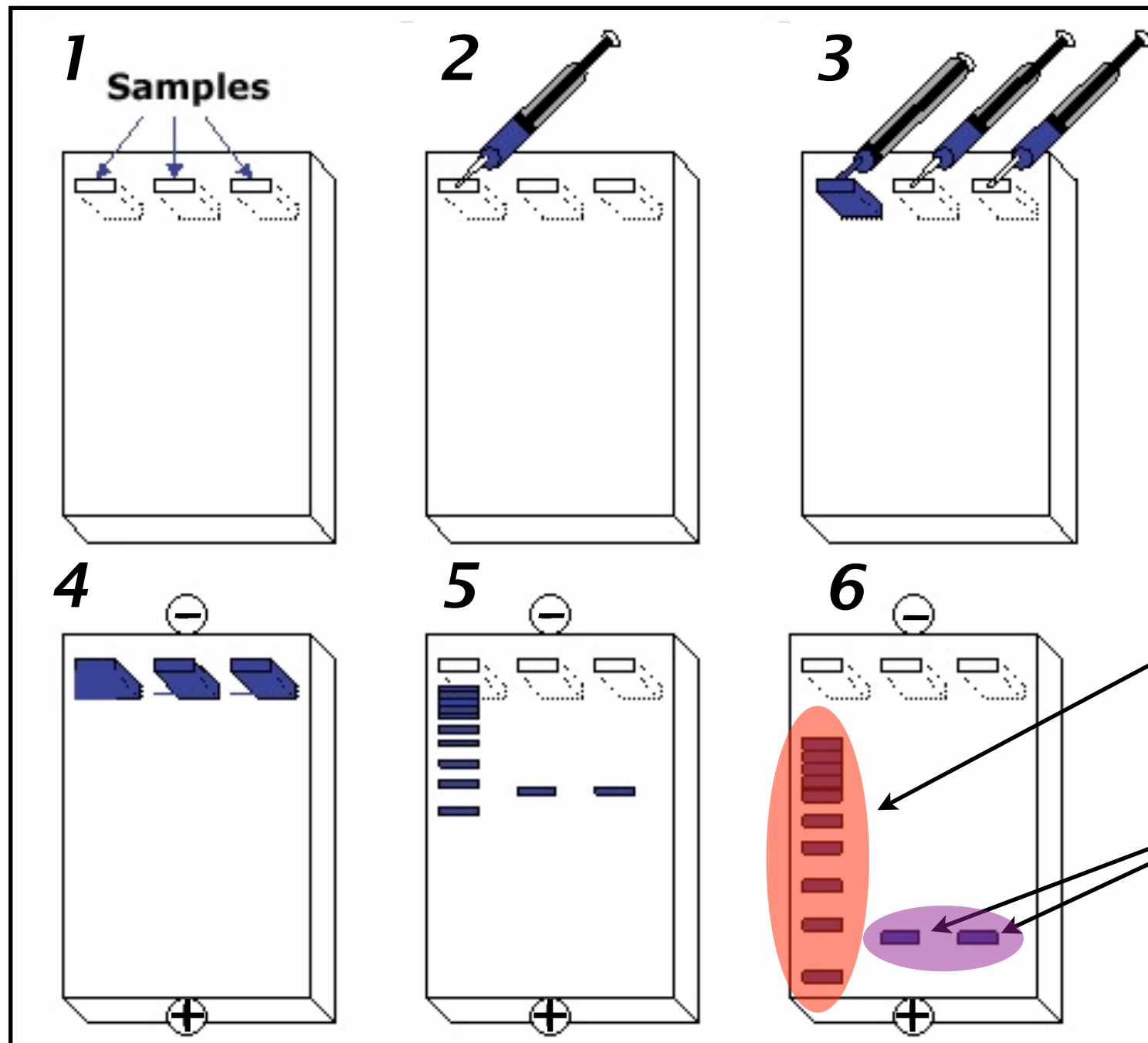
red algae

Gel Electrophoresis

- *PCR reaction is loaded into the gel*
- *Ethidium bromide in the gel binds to the DNA fragments and illuminates under UV light*
- *Large pieces move more slowly*
- *Small pieces move more quickly*



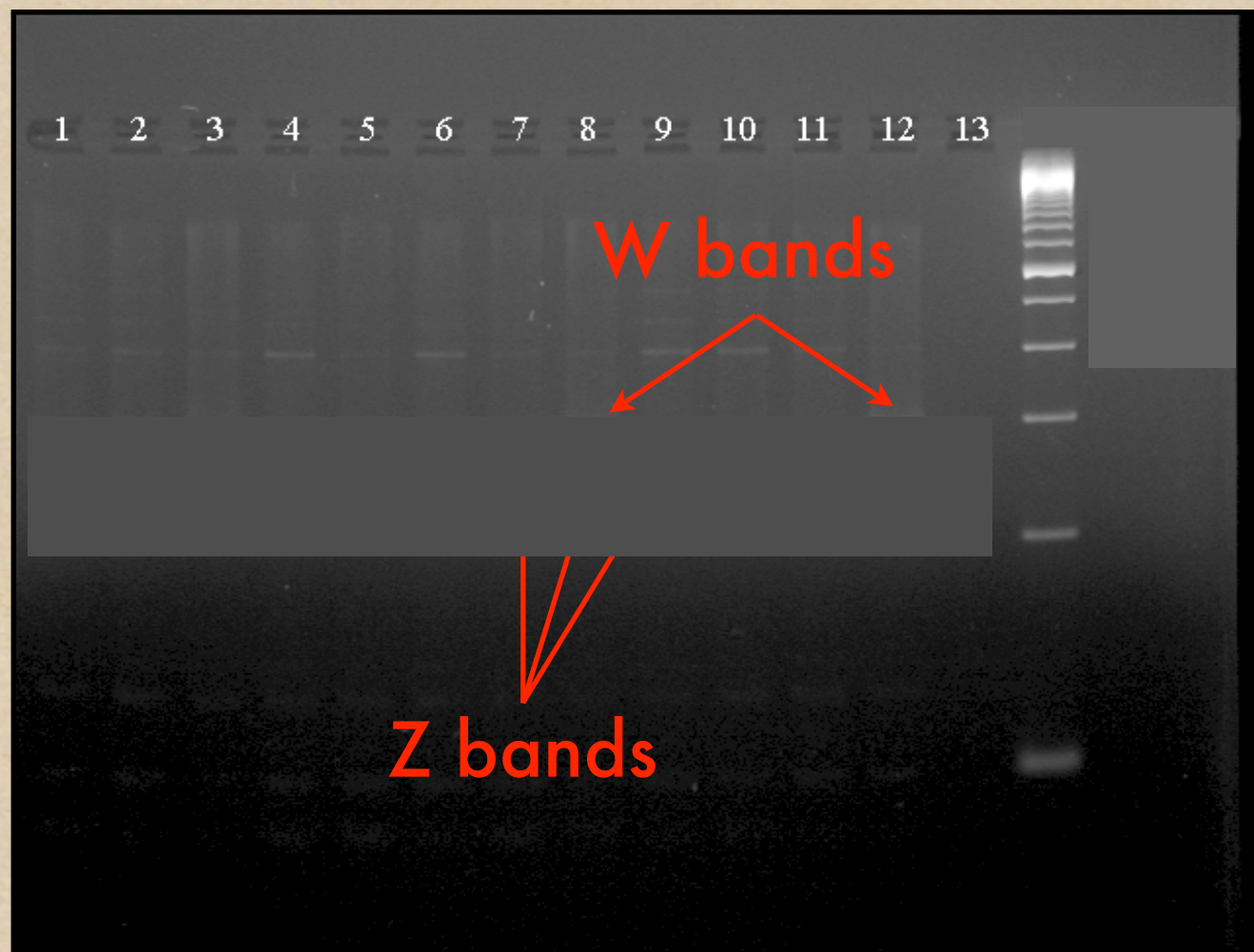
Gel Electrophoresis



DNA ladder

PCR products

Gel Electrophoresis



The target region for our condor sexing gene is ~250 bases long on the Z chromosome and ~300 bases long on the W

Chromosome Analysis



Male

Female

The California Condor's Future

- There are now breeding populations in the wild in California, Arizona, and Baja California***
- The hope is that someday we'll see one large breeding metapopulation***
- First delisting will occur at 450 breeding pairs***
- Back in San Diego County after nearly a century***

