What is Genetics?

It is the field that studies the "language" that dictates the nature of all living things!

This is how families retain similarity

The study of **heredity** (the transmission of characters from parents to offspring).

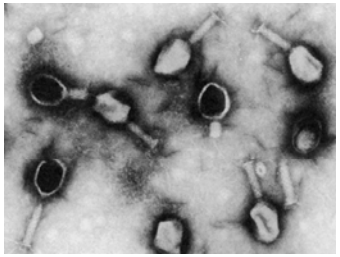
The study gene expression and of **variation** among individuals in populations.

This is why individuals are different!!

Why is Genetics Important?

1) Field that studies the common "language" or source of biological information used by all living things (and some not so living things).

Vertebrates **to** **Viruses**



DNA creates the "blueprint" for all living things, but RNA is used in some

2) It's the study of Inheritance or Heredity: Why offspring look like their parents.

His Mom

Snuppy

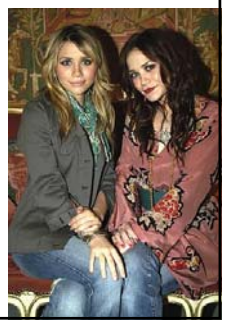
His Clone

3) It's the study of Variation: Why no two individuals are exactly the same.

Mary-Kate and Ashley use to be identical.

Genes and Environment influence the patterns of variation that we see!

And finance influence how we label these differences.



Now that they are older, they are not!!!

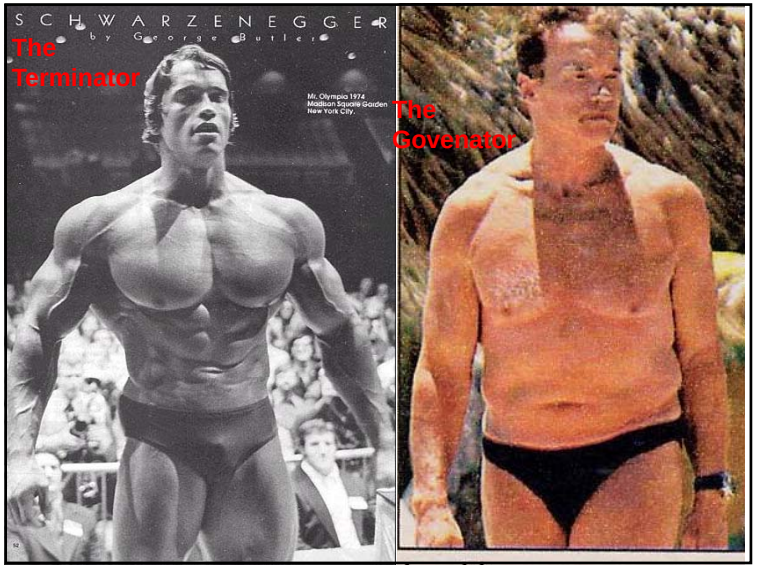
The "**Variation**" we do see is created by mutations and recombination.

The **raw material used by evolutionary processes** (**Natural Selection**) to shape the biological diversity (biodiversity) that we see in the world.

The raw material that has allowed humans to use **Artificial Selection** to shape the domesticated species that we d

5 genes here

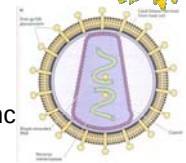
Is all the variation that we see caused by changes in our ge

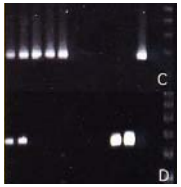


Important practical implications:

Agriculture
- Breeding
- GMOs

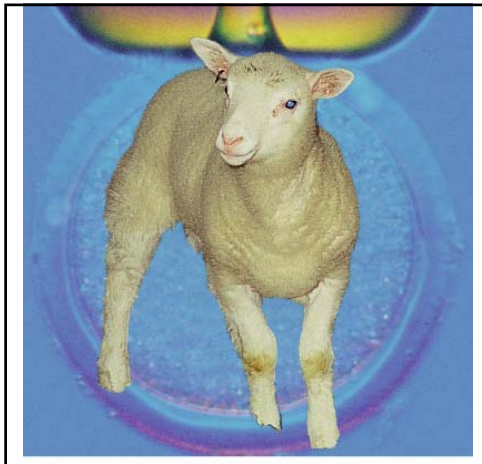
Human Health
- HIV
- BRCA1
- Antibiotic Resistanc
- H1N1





Many other areas: Forensics (DNA fingerprinting), Environmental protection/bio-remediation.... Cloning (Dolly, horse, Raelians)

"Genetics" is in the news just about everyday!



(a) Dolly

Genetics in the News

Who is Dolly and what happened to her?

Credit: I. Willmut, A.E. Schnleke, J. McWhir, A.J. Kind & K.H.S. Campbell. With permission from Nature, from cover of Nature, Feb. 27. 385: Issue 6619, 1997.

Technical Sidelight – Dolly the cloned sheep

The Daily Telegraph

www.telegraph.co.uk — Britain's biggest-selling quality daily — Saturday, December 28, 2002 90p

We've cloned baby, says cult

- Doubt and disgust over birth of 'Eve'
- Four more on way, claims scientist

N Korea orders UN team to leave

Who is Eve and what happened to her?

Colleen and Jeff Convery hold their daughter, Erika, who was conceived after fertility specialists at Brigham and Women's Hospital screened the parents' fertilized eggs to avoid Duchenne muscular dystrophy, a disease that strikes mainly boys.

Use Genetics to screen for diseases.

Muscular Dystrophy

A very early checkup

Genetic screening of embryos helps ease parents' fears, but is it a step toward 'designer babies?'

By M.E. Malone

Colleen Convery did not want her baby to suffer the same fate as her three

Use Genetics to understand how species evolve so quickly and to find cures!

The Boston Globe

Virtually untreatable' TB strain spreads

A deadly disease is said to lack cure

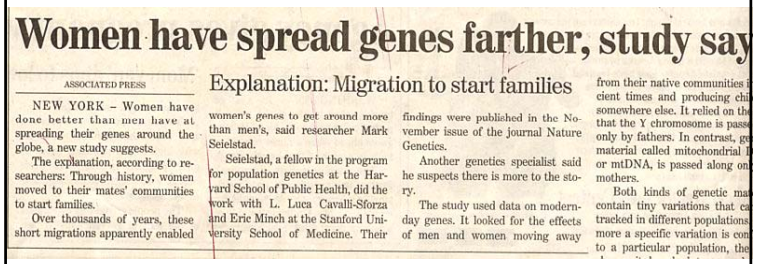
By Elisabeth Rosenthal, International Herald Tribune | September 6, 2006 PARIS –

The spread of a new, highly resistant form of tuberculosis that is ``virtually untreatable'' is causing alarm among international health officials who say that it has now been identified in ``all regions of the world,'' according to the World Health Organization.

Use Genetics to produce resistant crops and reduce pesticide use.

Fig 1.10b Side-by-side comparison of corn stalks from plants that are resistant (top) and susceptible (bottom) to the corn borer.

Use genetics to look at human history!!



Women have spread genes farther, study say

ASSOCIATED PRESS

Explanation: Migration to start families

NEW YORK – Women have done better than men have at spreading their genes around the globe, a new study suggests.

The explanation, according to researchers: Through history, women moved to their mates' communities to start families.

Over thousands of years, these short migrations apparently enabled women's genes to get around more than men's, said researcher Mark Seielstad.

Seielstad, a fellow in the program for population genetics at the Harvard School of Public Health, did the work with L. Luca Cavalli-Sforza and Eric Minch at the Stanford University School of Medicine. Their findings were published in the November issue of the journal Nature Genetics.

Another genetics specialist said he suspects there is more to the story.

The study used data on modern-day genes. It looked for the effects of men and women moving away from their native communities i cient times and producing chi somewhere else. It relied on the that the Y chromosome is passe only by fathers. In contrast, ge material called mitochondrial D or mtDNA, is passed along onl mothers.

Both kinds of genetic mat contain tiny variations that ca tracked in different populations more a specific variation is con to a particular population, the

Mitochondrial Genes are maternally inherited and can be use to track female lineage;
Genes on **Y chromosome are paternally** inherited and can be used to track male lineage.

Atlas of the Human Journey:
https://www3.nationalgeographic.com/genographic/atlas.html

Use of genetics to fight crime!! Forensics…CSI

Dog's DNA may be the smoking gun in Wash. murder trial

SEATTLE TIMES

SEATTLE – DNA from a dog may be used as evidence in a murder trial in Washington, perhaps its first such use in the United States.

King County Superior Court Judge Richard Jones has given preliminary approval for prosecutors to admit DNA blood tests from a pit bull that was shot and killed – along with its two owners – at a South Seattle house in 1996.

Prosecutors say the dog's DNA is crucial to their case.

Except for identical twins, no two people have the same genetic fingerprint found in the DNA in every cell of their bodies. Increasingly, courts are using DNA tests in criminal trials as evidence to link defendants to crime scenes or victims through semen, blood, hair, saliva or other biological traces.

In the case involving the pit bull, prosecutors say two men charged in the slayings had the dog's blood on their jackets – evidence that places both men at the scene of the killings.

A California company – PE Applied Biosystems – extracted bloodstains from 19 spots on clothing and matched them with blood from the dog. The test showed there was one chance in 350 million that the blood was not the dog's, prosecutors said.

"I think it [the dog DNA] is extremely relevant to our case," Timothy Bradshaw, senior deputy prosecutor, said. "It's the most probative evidence and the most objective evidence that the defendants were present while the crime was committed."

But attorney Pete Connick, who represents defendant George Tuileta, opposes having the dog's blood test admitted as evidence. Connick says he has asked Jones to reconsider his decision to allow it at trial.

"The potential abuse of DNA evidence in this case is extreme," Connick said. He further contends that the dog's blood is irrelevant to his client.

The dog, a pit-bull mix named Chief, died 20 hours after being shot repeatedly at a home in South Park on Dec. 9, 1996. Chief's owners, Jay Johnson, 22, and Raquel Rivera, 20, died at the scene from gunshots. Prosecutors say the men accused of the killings – Tuileta and Kenneth Leuluaiali – kicked down the door of the house after Johnson refused to sell them marijuana, then shot the dog, Johnson and then Rivera.

Joy Halverson, scientist at PE Applied, said cat DNA was used in a case in Canada, but she thinks this will be the first time dog DNA has been used in the United States.

2500 Year History of Genetics

330 BC Aristotle
250 BC Theophrastus
0
1640 Harvey
1677 Leeuwenhoek
1694 Camerarius
1770 Wolf
1809 Lamark
1824 Amici
1859 Darwin
1866 Mendel

How are offspring produced?
Early "understanding" of the connection between sex and reproduction.

How does sex work to create new beings?
Early "understanding" of Procreation.

How are characters inherited?

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How are offspring produced?
Early "understanding" of the connection between sex and reproduction.

Aristotle (384-322 BC) Knew (**hoped**) male humans were important. They provided the **"vital heat"** that cooked or shaped some female component.

Theophrastus "Enquiry into Plants" 250 BC
The pollination ceremony of the Date Palm by priests. Contact of male tree to female tree was the only way to insure good fruit production.

Leeuwenhoek Dutch (**1677**) discovered (with primitive microscope) sperm in animals "wild animalcules arising in seminal fluids by putrefaction."

Camerarius (1694) at Tubingen Bot Gardens (Germany)
Observed that Female mulberry without Male yields no seed. Worked with many plants (corn) and showed the removal of stamens prevented seed formation.
"In the plant kingdom the production of seed which is the most perfect gift of nature and the general means of maintenance of a species, does not take place unless anthers have previously prepared the young plant contained in the ovary".

At this stage the Sex-Reproduction Connection was made in the "scientific community". Again, for at least animals this connection was clear earlier.

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How does sex work to create new beings?
Early "understanding" of Procreation.

How are characters inherited?

How does sex work to create new beings?--Early Understanding of Procreation.

Theories:

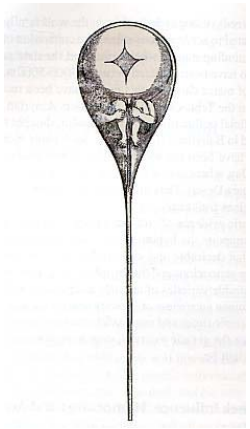
Preformation and homunculus (ovists vs. spermists!!??).

Epigenesis: structures not present in early embryos but newly formed (Harvey 1640s)

Casper Wolf (1733-1794) an embryologist showed adult structures absent in embryo.

Amici (1824) an astronomer. Watched for 3 hrs and saw pollen grain germinate, grow and enter embryo sac. **"tubes elongate bit by bit and finally come in contact with ovules, one tube for each ovule."**

These observations killed Preformation Theory and showed fusion of male and female cells was required for reproduction



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How are characters inherited?

Lack of understanding about how sex leads to reproduction (union of male and female cells) does not mean there was no understanding of inheritance.

People certainly have had a sense that characters are inherited. Simple understanding that "like begets like"

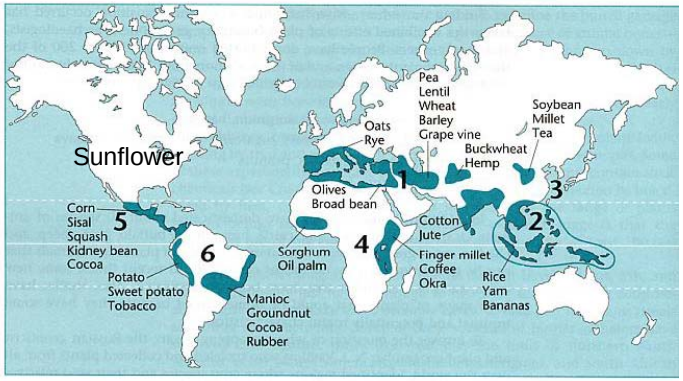
Hindu saying: "a man of base descent never escapes his origin"

disease and occupation are inherited??!!

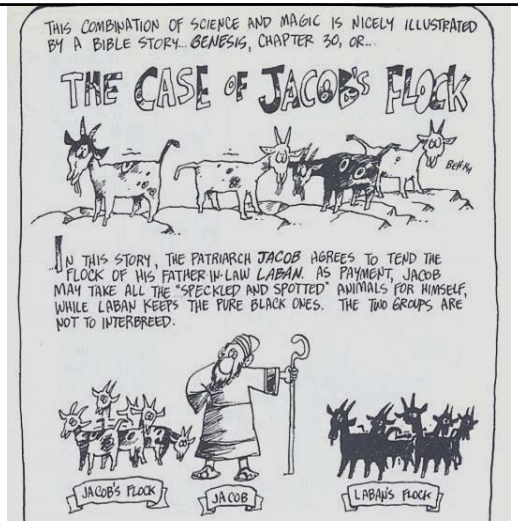
Agriculture: (Breeding…controlled evolution)

Biblical story:

How are characters inherited?



Primitive methods creating Genetically Modified Organisms (GMOs)



From: Gonick & Wheelis, Cartoon Guide to Genetics

Laban's

Jacob's

bb

BB Bb

Once the understanding of sex and reproduction was clarified (union of male and female cells) in the 1700s, the direction of **discussion changed from problem of procreation to inheritance and variation.**

How are characters inherited? Why do they vary? Why are individuals and species different?

Blending inheritance (intermediacy of hybrids) was the prevailing theory in 1700-1800s.

Blending Inheritance: the problem:

Darwin realized that blending inheritance however would diminish variation.

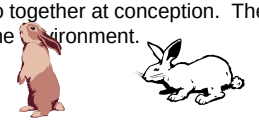
Evolution by Natural Selection (nature does what humans have been doing by artificial selection) depends on heritable variation.

Darwin adopted Lamark's (1809) ideas to solve blending inheritance theory deficiency.

Doctrine of **use and disuse** and **inheritance of acquired characteristics** would generate variation lost by Blending.

Theory of **pangenesis** that heritable materials (gemmules) were floating in the body and come to together at conception. The gemmules can be affected by the environment.

Frances Galton's test.



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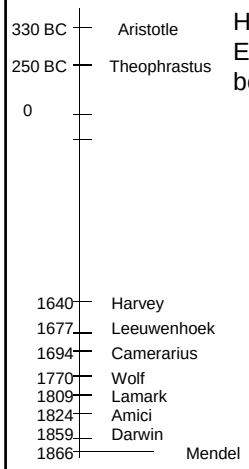

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How are characters inherited?

By late 1800's two merging approaches:

A. **Transmission studies:** (hybridizers) **Kolreuter**, and culminating with **Mendel's** (1866) work. Ch. 3-5

B. **Cytology**; starting with primative microscopes used by Leeuwenhoek through Amici and culminating with **T. Boveri** and **Walter Sutton**. Sutton proposed the **chromosomal theory of heredity** (**1903)**. They proposed that the hereditary factors of Mendel were located on chromosomes. Ch. 2, 7, 8

Beginning in the 1950s a third approach:

C. **Molecular Genetics:** With the discovery of the structure of DNA this approach rapidly advanced Ch. 10-