"There have been 289 post-conviction DNA exonerations in the United States. The first DNA exoneration took place in 1989. Exonerations have been won in 35 states; since 2000, there have been 222 exonerations. 17 of the 289 people exonerated through DNA served time on death row."

– "Facts on Post-Conviction DNA Exonerations", The Innocence Project

"This is a fake."

– Tom Keating

"Ever been had?"

– Tom Keating

Evidence and Hypothesis:
DNA, Art Fraud, and the Shroud of Turin

Supplementary Material for CFB3333/PHY3333

Professors John Cotton and Stephen Sekula

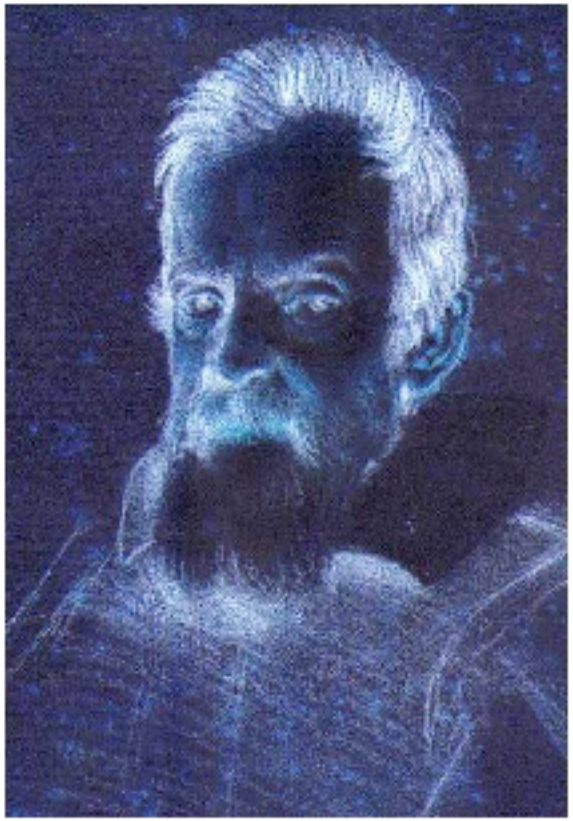
January 27, 2012

Based on the following information on the web:

http://www.physics.smu.edu/pseudo/DNA/

But first . . . some last thoughts on Galileo

Galilean Method



(Galileo Galilei: 1564-1642)

Argument by evidence: experiment is the only way to gather objective evidence, upon which argument should be based.

Galileo's conclusion contradicted the widely held belief, based on "common sense" and Biblical scholarship, that the Earth was the center of the cosmos. For his arguments, and his publications, he was brought before the Inquisition and forced (on penalty of death) to recant his "opinion" and affirm the word of the Bible. He was placed under house arrest for the remainder of his life. Ironically, while under house arrest he revisited some old work he had abandoned and began to write down the laws of motion. These were formalized by Sir Isaac Newton, who was born in the same year Galileo died.

Galileo's major publication, containing all his data and arguments, was entitled "Dialogue on the Two Chief Systems of the World." It was formally removed from the Vatican's banned books list in 1835. Pope John Paul II apologized for the "Galileo affair" in 1992, referring to it as a "tragic mutual incomprehension."

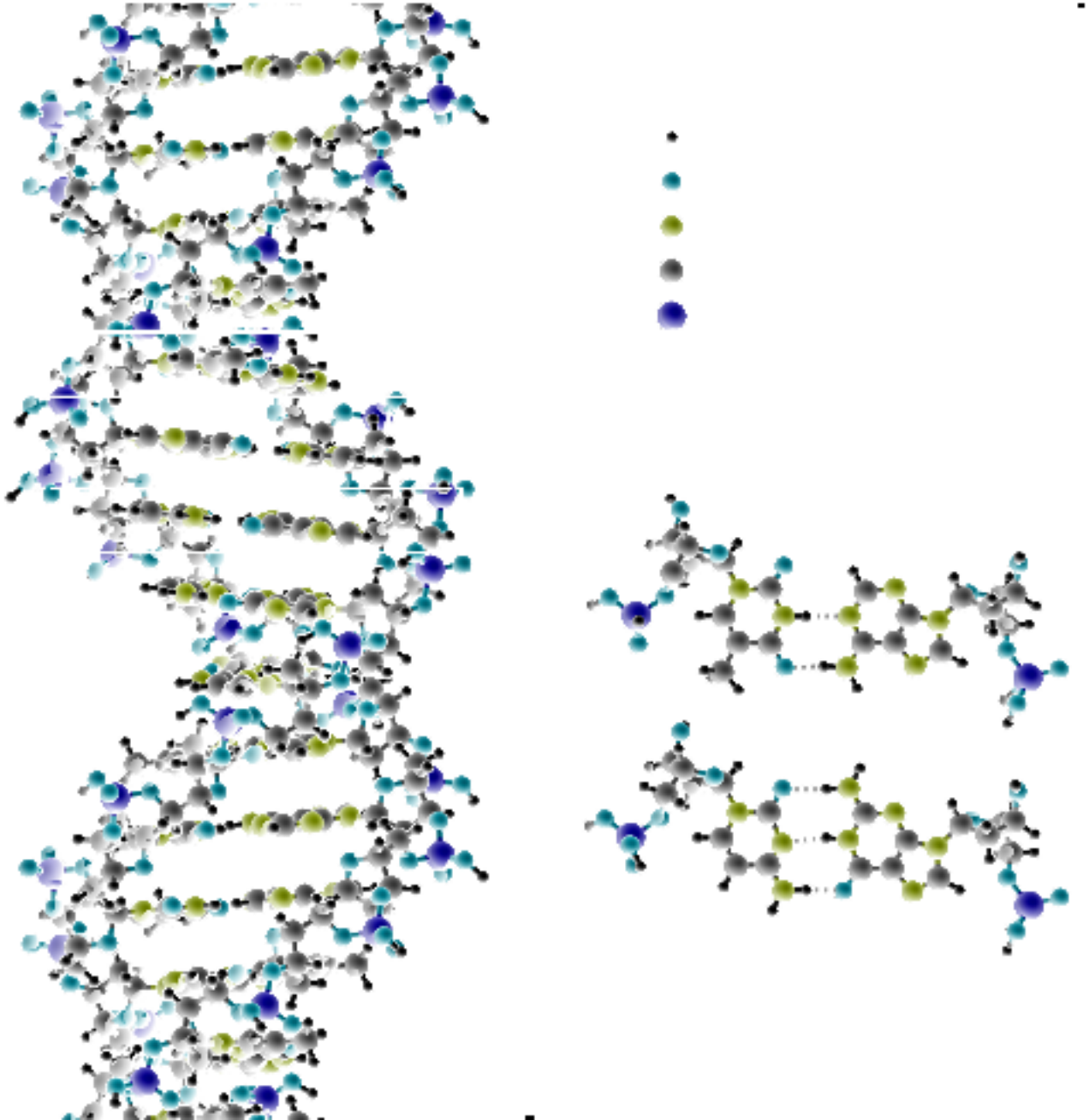
http://www.physics.smu.edu/pseudo

Apollo 15 Mission (1971): http://www.youtube.com/watch?v=5C5_dOEyAfk

What does experiment/evidence do to an hypothesis?

In other words, what does evidence rule in or rule out as regards a claim or an observation?

DNA: Deoxyribonucleic Acid



The (very short) Story of DNA

- A biological source of heredity is predicted by the Theory of Evolution "(descent, with modification"). Darwin incorrectly speculated at the mechanism ("pangenesis")
- An Augustinian Friar, Gregor Mendel, is the first to show that heredity follows a distinct pattern (1856-1863) although his work was rejected until the early 1900s
- DNA is first isolated in 1869 (Miescher) as "nuclein"
- Basic research continued on "nuclein"(eventually renamed "nucleic acid") for decades, revealing its contents but not its structure or its function. Many researchers contributed during this period.
- DNA's role in heredity was confirmed only in 1952 (Hershey and Chase)
- Franklin and Gosling create a single x-ray photograph of DNA that in May, 1952
- Watson and Crick propose, based on the Franklin image, the "double-helix" model of DNA in 1953 to explain its properties. Five publications follow that confirm with evidence the proposed structure.
- Watson, Crick, and Wilson share the 1962 Nobel Prize in Physiology or Medicine. Franklin died before the prize was awarded.

Charles Darwin (late 1830s)

Gregor Mendel

Rosalind Franklin

James Watson (left) and Francis Crick (right)

DNA as legal evidence

- First use of DNA as evidence was in 1987
  - "the Circuit Court in Orange County, Florida, convicted Tommy Lee Andrews of rape after DNA tests matched his DNA from a blood sample with that of semen traces found in a rape victim." [1]
- First court case to challenge DNA evidence was 1989. The court held that:
  - DNA identification theory and practice are generally accepted among the scientific community.
  - DNA forensic identification techniques are generally accepted by the scientific community.
  - Pretrial hearings are required to determine whether the testing laboratory's methodology was substantially in accord with scientific standards and produced reliable results for jury consideration.

DNA as legal evidence (cont.)

- DNA samples are taken at a crime scene, from a victim, and/or from a suspect
- The samples are compared to determine the degree of match
- Samples that don't match have nothing in common; samples that do match may imply the suspect or a blood relative was involved
- DNA's role as evidence – can DNA alone exonerate or convict with 100% certainty?
  - it can exonerate with 100% certainty
  - it cannot convict with 100% certainty
- The Innocence Project (http://www.innocenceproject.org/)

http://www.physics.smu.edu/pseudo

Edgar Degas had an interest in painting ballet dancers starting in the 1870s. Do you think that all of these paintings are by Degas?

http://www.physics.smu.edu/pseudo

Paintings A and D are believed to have been painted by Degas.

Paintings B and C are known fakes, produced by Tom Keating.

Discussion – Art Fraud

- How might you detect art fraud?
  - Brainstorm!

Discussion – Art Fraud

- How might you detect art fraud?
  - some modern techniques
    - x-ray imaging ("see what can't be seen")
    - x-ray diffraction and fluorescence and chemical analysis: identify the chemical ingredients in paint, measure purities of materials, etc. (a forgery may be too pure)
    - stable isotope analysis: can be used to identify the quarry where stone was cut for a sculpture.
    - carbon dating: use the ratio of carbon isotopes, a very sensitive clock, to date (if a sample is less than 10,000 years old, the accuracy of the dating is better than 30 years)
    - digital authentication: brush stroke analysis allows for "confirmed" paintings to be then compared to presumed forgeries

http://www.physics.smu.edu/pseudo

"Portrait of a Woman"

Attributed to Goya (1746-1828)

X-ray images of the painting revealed another image of a woman underneath the top layer of paint.

X-ray diffraction revealed the presence of zinc white paint in the surface layer. Zinc white paint was developed AFTER Goya's death.

The surface paint was analyzed and found to be modern.

Conservators decided to leave the painting as shown right, with the old and the new painting each revealed in part.

Art forgery can get complicated!

Art Fraud: Summary

- Evidence can only confirm an art forgery with 100% certainty
- Evidence cannot confirm the authenticity of artwork to 100% certainty
  - a forger may use materials from the period to evade carbon dating
  - they may mix paint from the period, to avoid x-ray analysis
  - etc. You cannot know FOR CERTAIN a painting is authentic
  - Provenance – the detailed record of how the art changed hands – can provide assurance of authenticity (though no guarantee) if the record goes back to the time when the work was made.

http://www.physics.smu.edu/pseudo

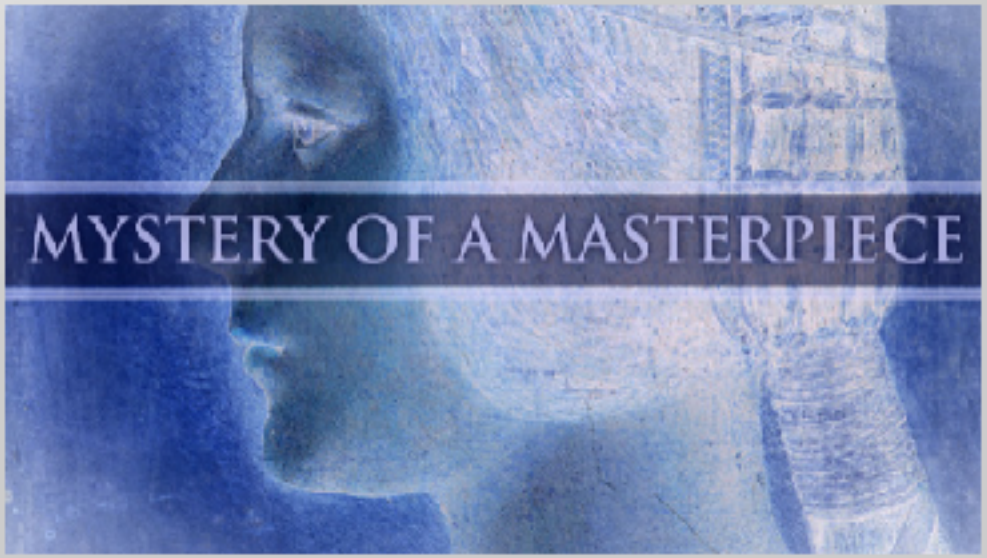
NOVAWEDNESDAYS

Mystery of a Masterpiece

Art experts investigate whether a portrait sold for about $20,000 in 1998 is actually a lost Leonardo worth millions. Aired January 25, 2012 on PBS

Posted 12 22 11

NOVA



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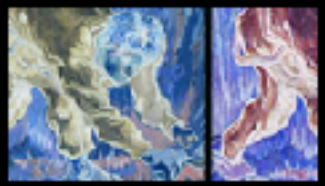

Catching a Copy

http://www.pbs.org/wgbh/nova/tech/mystery-masterpiece.html

The Shroud of Turin

http://www.physics.smu.edu/devel/pseudo/Shroud/