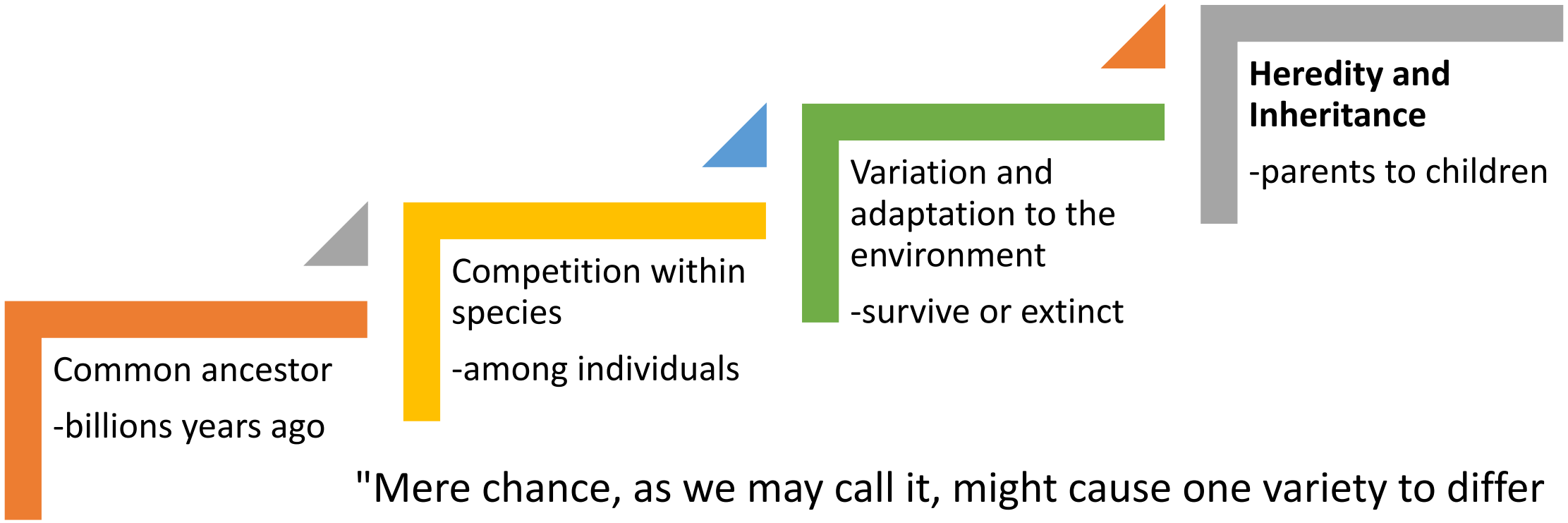
Lecture 6
Watson

GFN1000 In Dialogue with Nature

Darwin's Difficulty: How Do Species Inherit Traits?



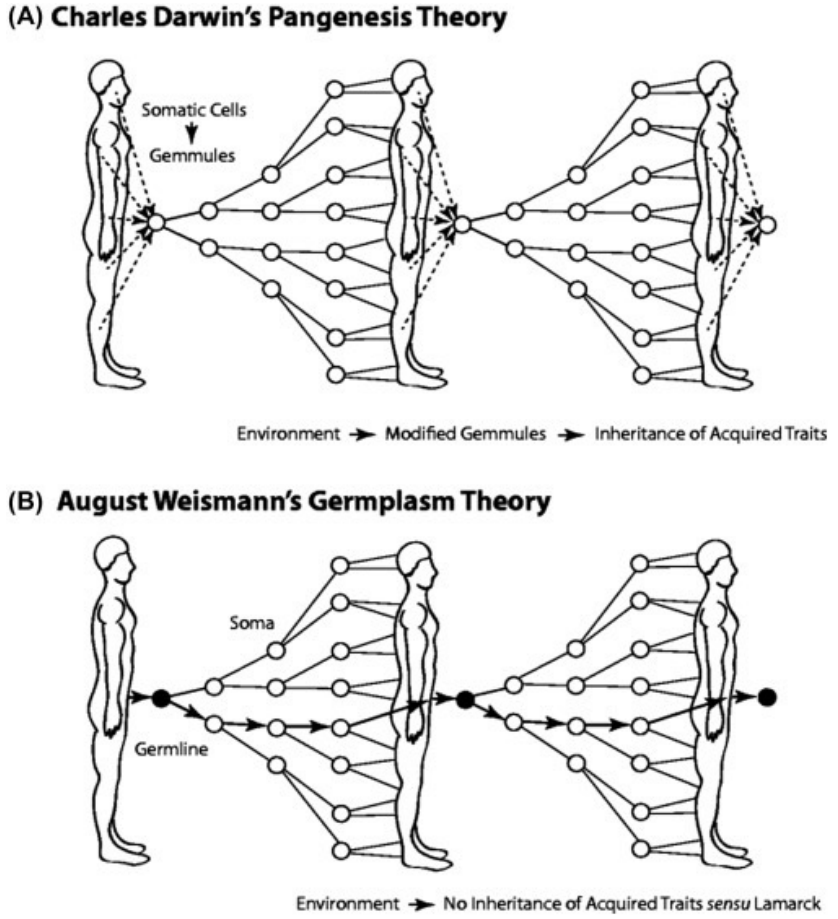
"Mere chance, as we may call it, might cause one variety to differ in some character from its parents, and the offspring of this variety again to differ from its parents in the very same character and in a greater degree." – Darwin, *Origin of Species*, 1:42

Content

1. Pre-modern Theories of Heredity
   - Pangenesis and Preformationism
2. Progress in Modern Genetics
   - Mendelian Inheritance (1866)
   - Morgan and Sex-Linked Inheritance (1911)
3. The Double Helix
   - Schrödinger: What is Life? (1944)
   - James Watson, *et al*. (1953)
4. Eugenics

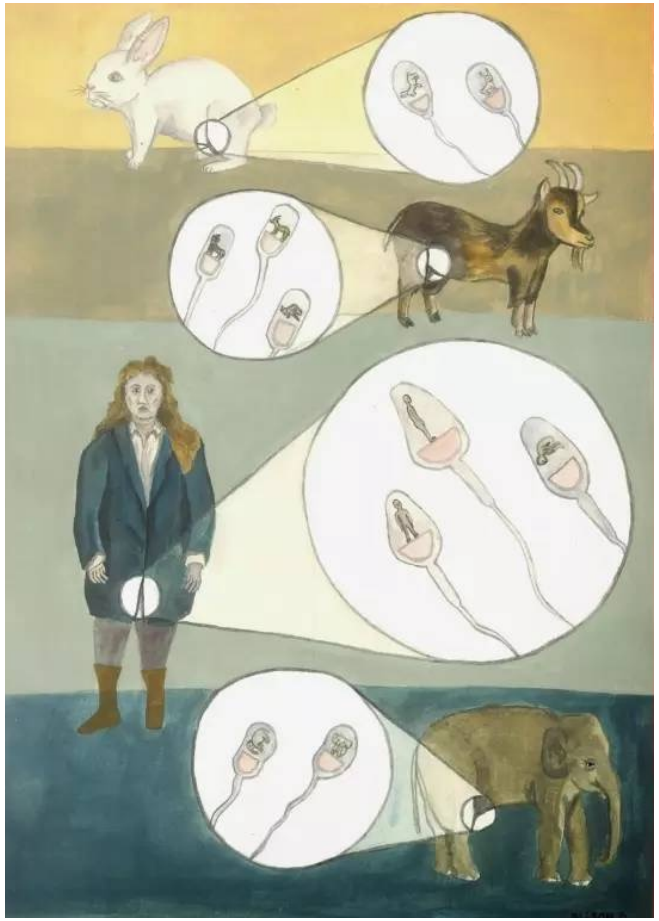
Pangenesis

- First proposed by the father of medicine - Hippocrates (460-370BC)
- Adopted by Lamarck and Darwin
- Heredity: transfer of miniature body parts (gemmules)
- Disapproved by August Weismann's (1834-1914) experiment



Preformationism

- Organisms develop from miniature versions of themselves.
  - Supported by Pythagoras and Aristotle
- Antonie van Leeuwenhoek (1632- 1723)
  - "Father of microbiology"
  - 1st one to observe sperms with a microscope (1677); claimed the sperm contained a complete, preformed individual
- Disapproved by more advanced microscopes

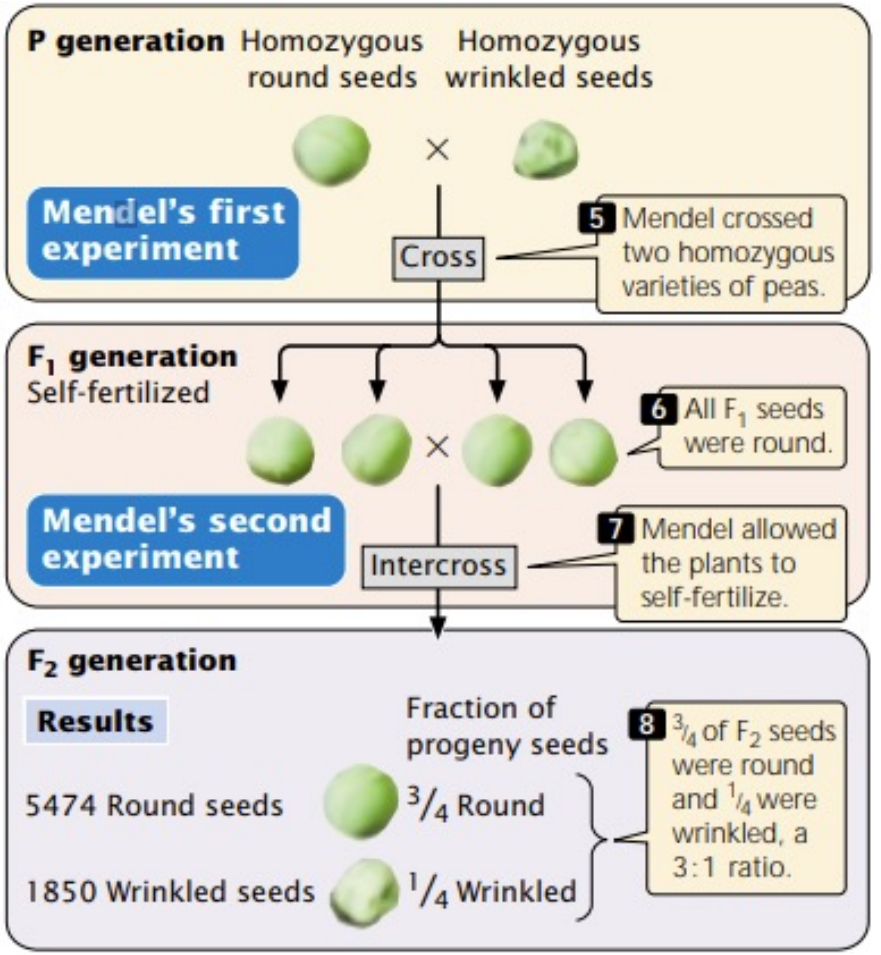


Heredity

- Inherited attributes
  - Observable body characters: Habsburg jaw
- Genetic diseases
  - Intermarriages within clans (George III's Porphyria)
- Applied in improving domesticated animals
  - Faster horses; plants with bigger fruits
- Features can come from heredity and development

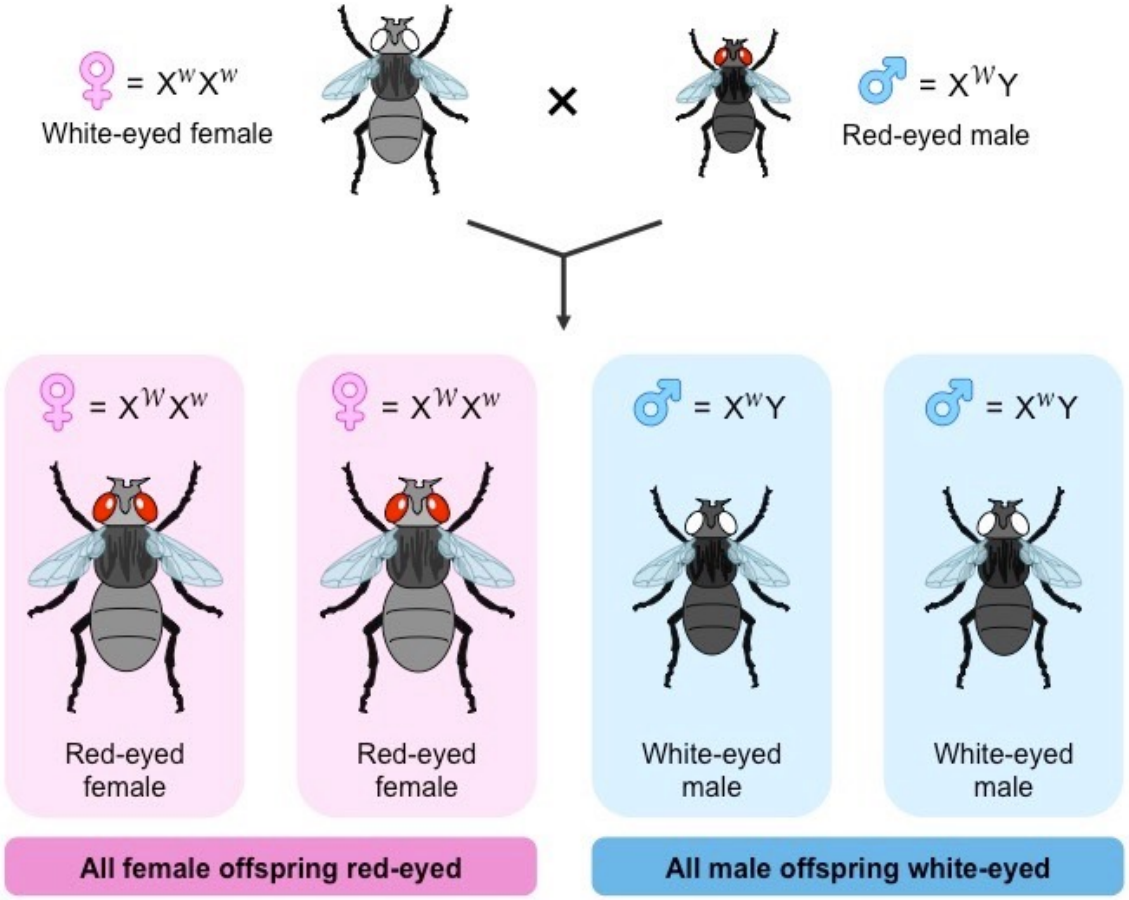
Gregor Johann Mendel (1822-1884)

- Father of modern genetics
- Mendel's work (1866) on his experiments of cross-breeding pea plants.
  - Revealed that **hereditary factors** come in pairs, and offspring receives one from each parent.
  - Distinguished between the **dominant** and **recessive** factor
- Rediscovery of Mendel (1900)



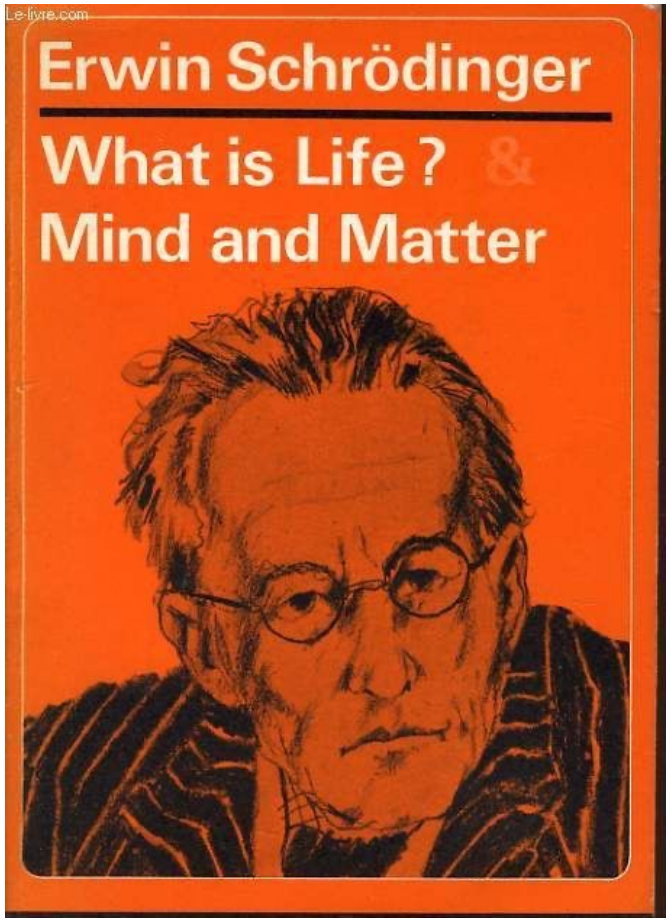
Thomas Hunt Morgan (1866-1945)

- Established the chromosomal theory of heredity
  - Experiments with fruit flies
- Received the Nobel Prize in 1933
- Sex-linked traits
  - Particular characteristics disproportionately represented in one sex.



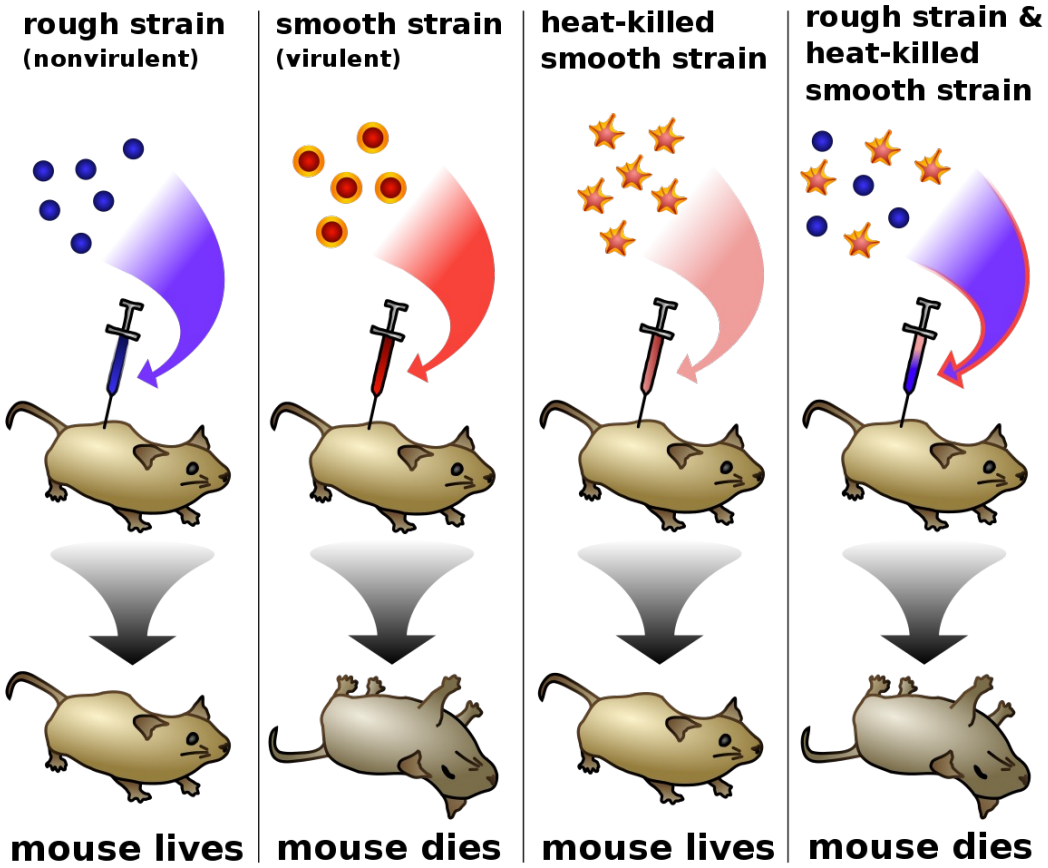
Erwin Schrödinger (1887-1961)

- Austrian theoretical physicist
  - Nobel Prize in Physics (1933) for the discovery of new productive forms of atomic theory
- What Is Life: The Physical Aspect of the Living Cell (1944)
  - Life – contrary to the general tendency dictated by the **second law of thermodynamics** – decreases or keeps constant its entropy by feeding on negative entropy



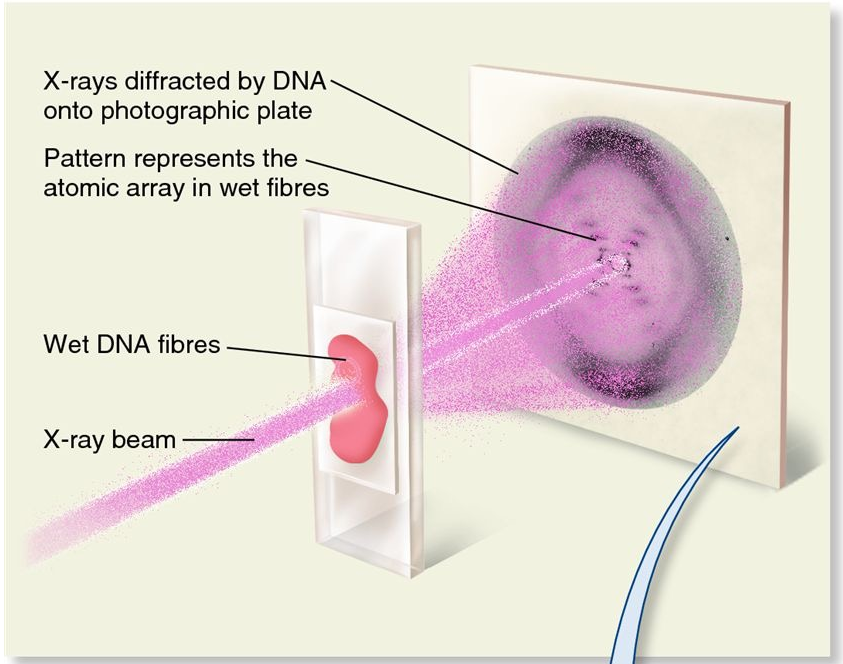
Developments in Genetic Research

- Friedrich Miescher: Isolation of nuclein (1869)
- Frederick Griffith: Griffith's experiment (1928)
- Avery–MacLeod–McCarty experiment (1944)
- Hershey-Chase experiment (1952)
- Watson-Crick, Wilkins', Franklin's three papers (1953)



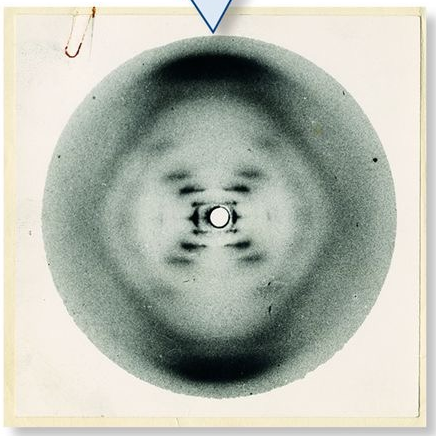
Evidence

- Alexander Todd proved in 1951 that the chemical bonds linking nucleotides in DNA were always the same.
- Erwin Chargaff discovered in 1950 that the number of **G**uanine units equals the number of **C**ytosine units, and the number of **A**denine units equals the number of **T**hymine units.
- Franklin's Photo 51 supported the helical structure of DNA as critical evidence.



(a) The method of X-ray diffraction

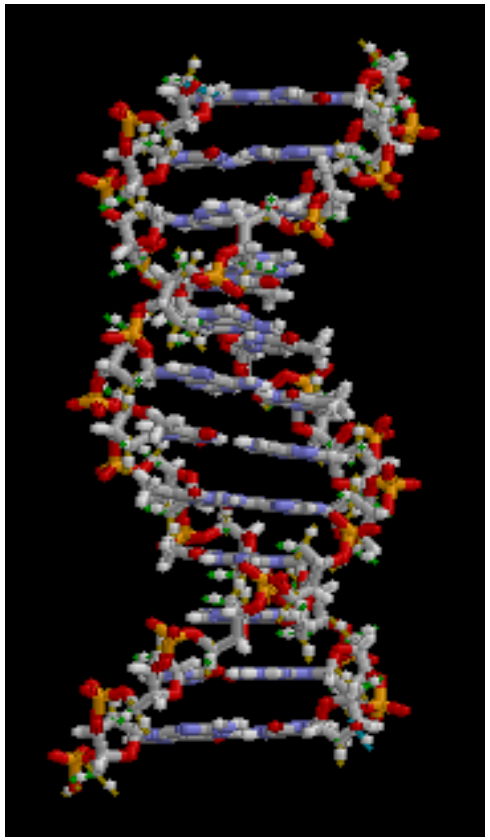
(b) Rosalind Franklin



(c) Franklin's X-ray diffraction pattern of wet DNA fibres

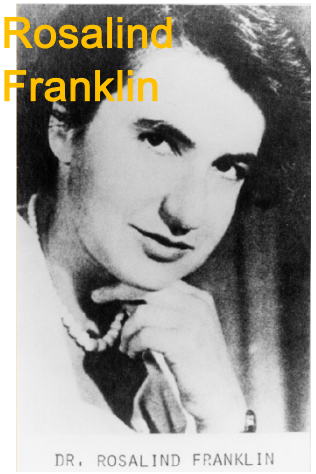
Double Helix Structure

- Deoxyribonucleic Acid (DNA)
  - Four nitrogenous bases (碱基): Adenine (腺嘌呤)，Guanine (鸟嘌呤), Cytosin (胞嘧啶)，Thymine (胸腺嘧啶)
- Semi-conservative replication: The Meselson And Stahl Experiment (1958)
- Mutation: change in the sequence of the nitrogenous bases



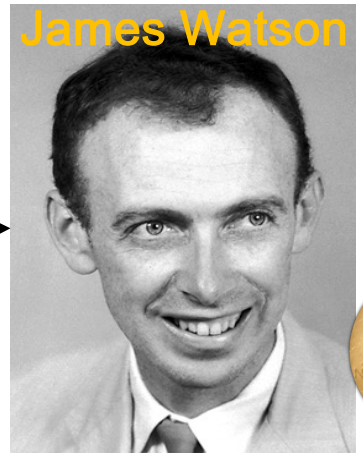
James Watson (1928-)

- Born in Chicago, BS in Zoology in 1947 (Chicago, aged 19), PhD in Zoology in 1950 (Indiana, aged 22)
- Postdoc at Cambridge Cavendish Laboratory, co-discoverer of DNA structure in 1953 (aged 25)
- Recipient of the 1962 Nobel Prize in Physiology or Medicine together with Crick and Wilkins (aged 34)



Rosalind Franklin

Dislike



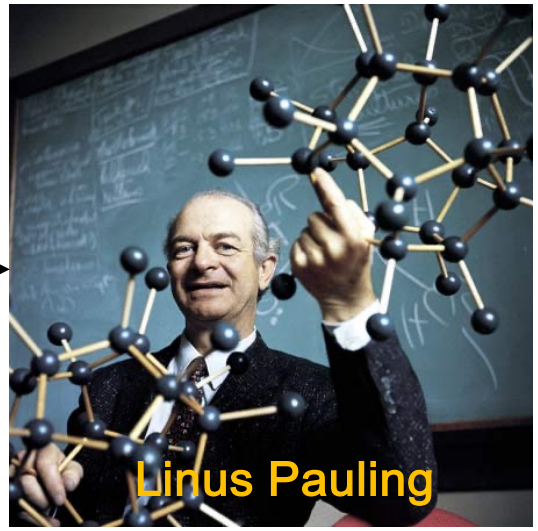
James Watson

Colleague, dislike

(Friend)

Colleague, close friend

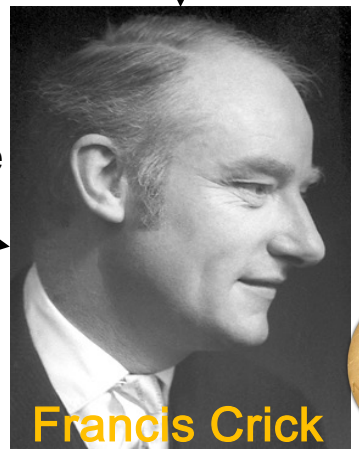
Rival



Linus Pauling

Maurice Wilkins

Friend, rival (complicated)



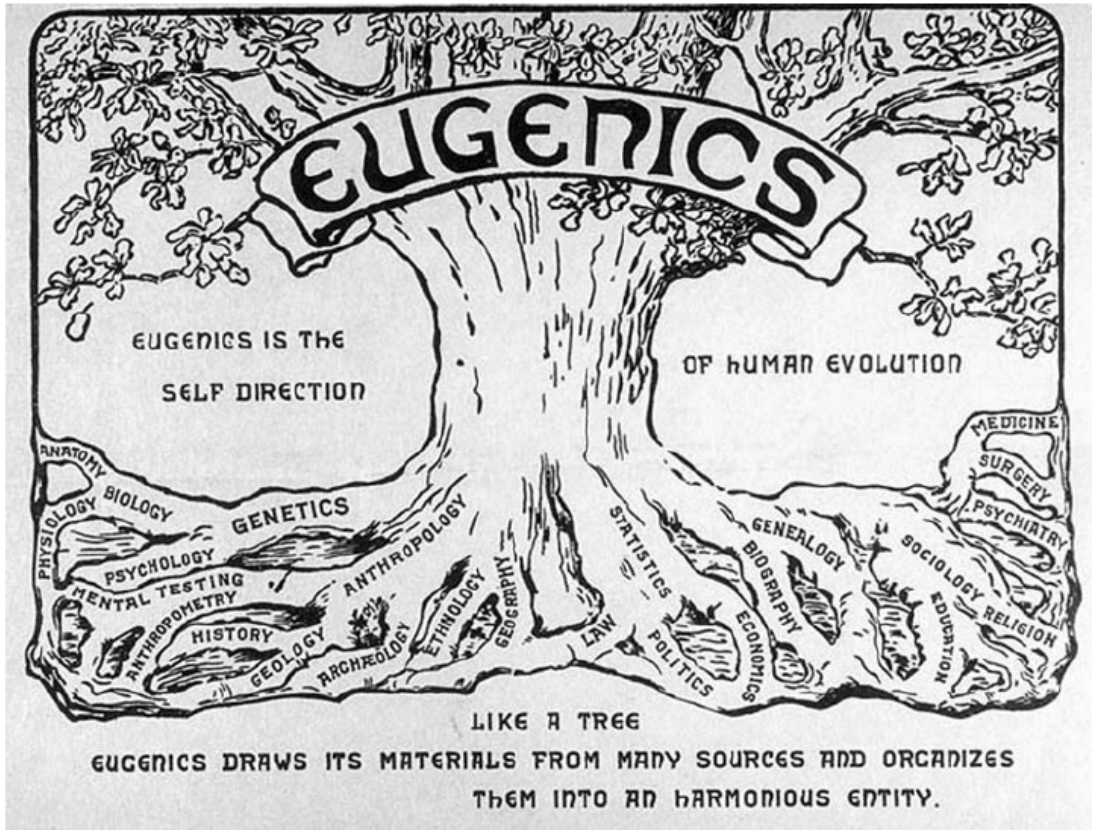
Francis Crick

Francis Galton (1822-1911)

- Half-cousin of Charles Darwin
- Father of Eugenics: coined the term eugenics
- Obsessed with measuring everything, such as IQ
- "Improving" the human race by preferential breeding - similar to agricultural breeding of animals and plants, only this time consciously conducted by the species itself.

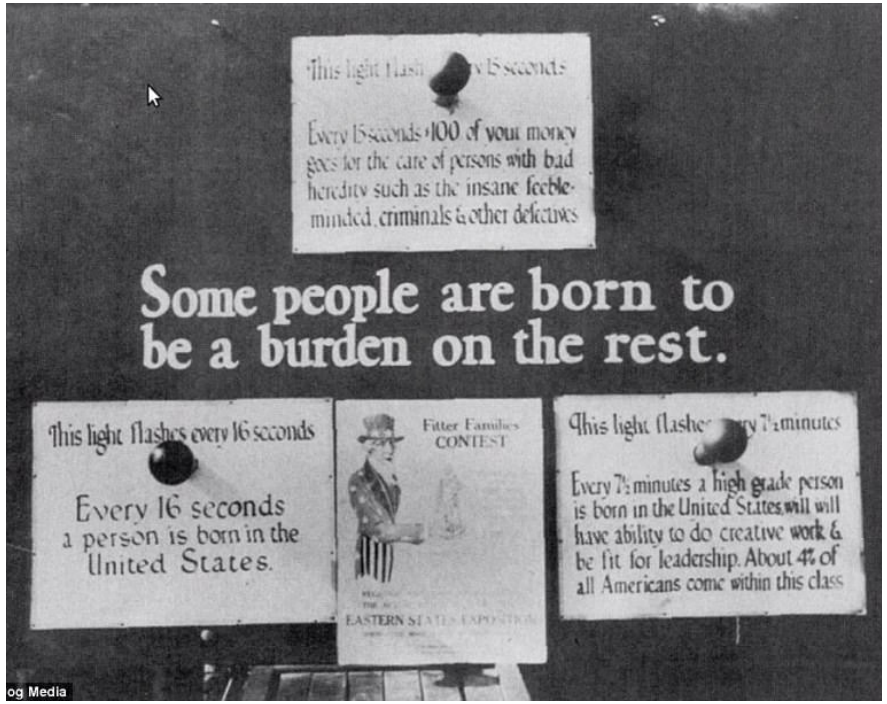
Eugenics

- A movement started in the UK in the late 19th and early 20th century in Western countries
- Self-directed human evolution: to raise the physical and mental level of the race.
- Old-fashioned way: those with "superior qualities" reproduce
- New way: genetic engineering



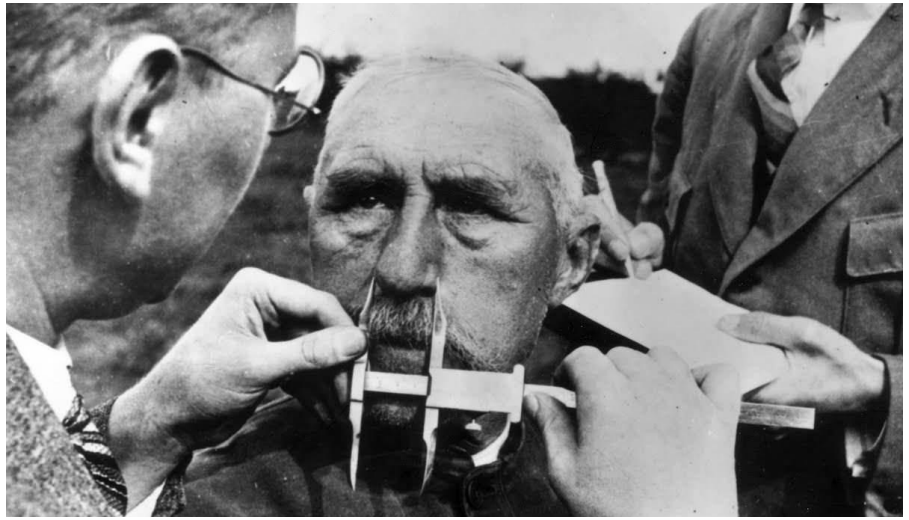
Eugenics in the United States (1907-1963)

- Many became convinced that traits like intelligence, sexual orientation, and criminality were caused by bad blood.
- Over 60 thousand people have been the victims of this movement. Most were the poor, the disabled, and the mentally ill.
- Most of those who were sterilized were women from communities of color.

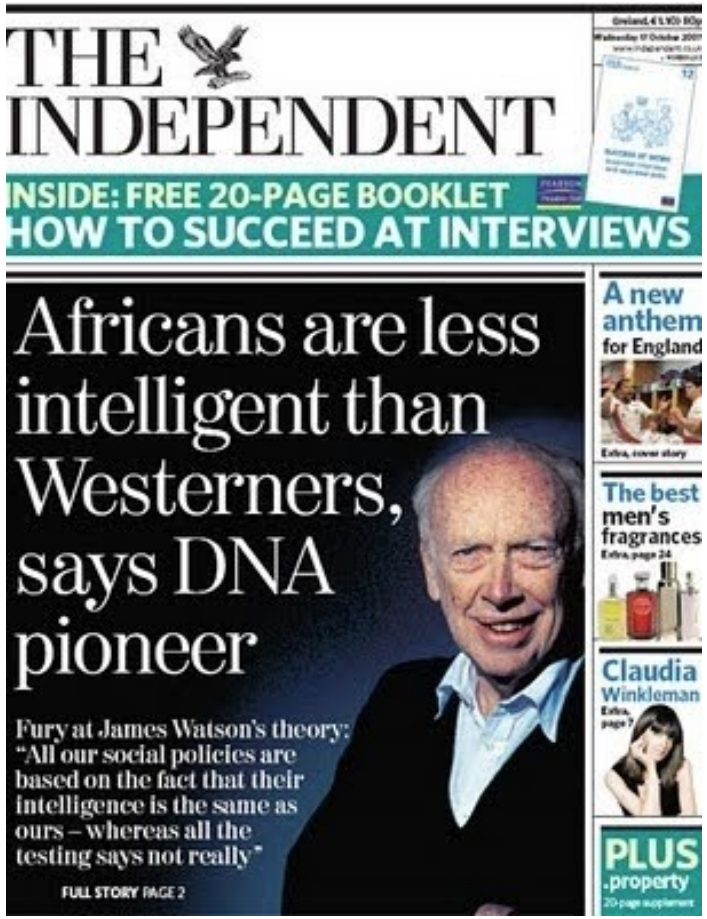


Nazi Eugenics

- Lebensunwertes Leben: Life unworthy of life
- Eugenics used to promote the superiority of the Aryan race; laws were created to sterilize "degenerates", including the disabled, homosexuals, and non-Aryan racial groups
- Sterilization → euthanasia → genocide
- Fritz Lenz: Nazism is nothing but applied biology.



Misuses and Abuses of Science



Nature vs. Nurture

- Nature: our genetics determine our behavior. Our personality traits and abilities are in our **nature**.
- Nurture: our environment, upbringing, and life experiences determine our behavior. We are **nurtured** to behave in certain ways.