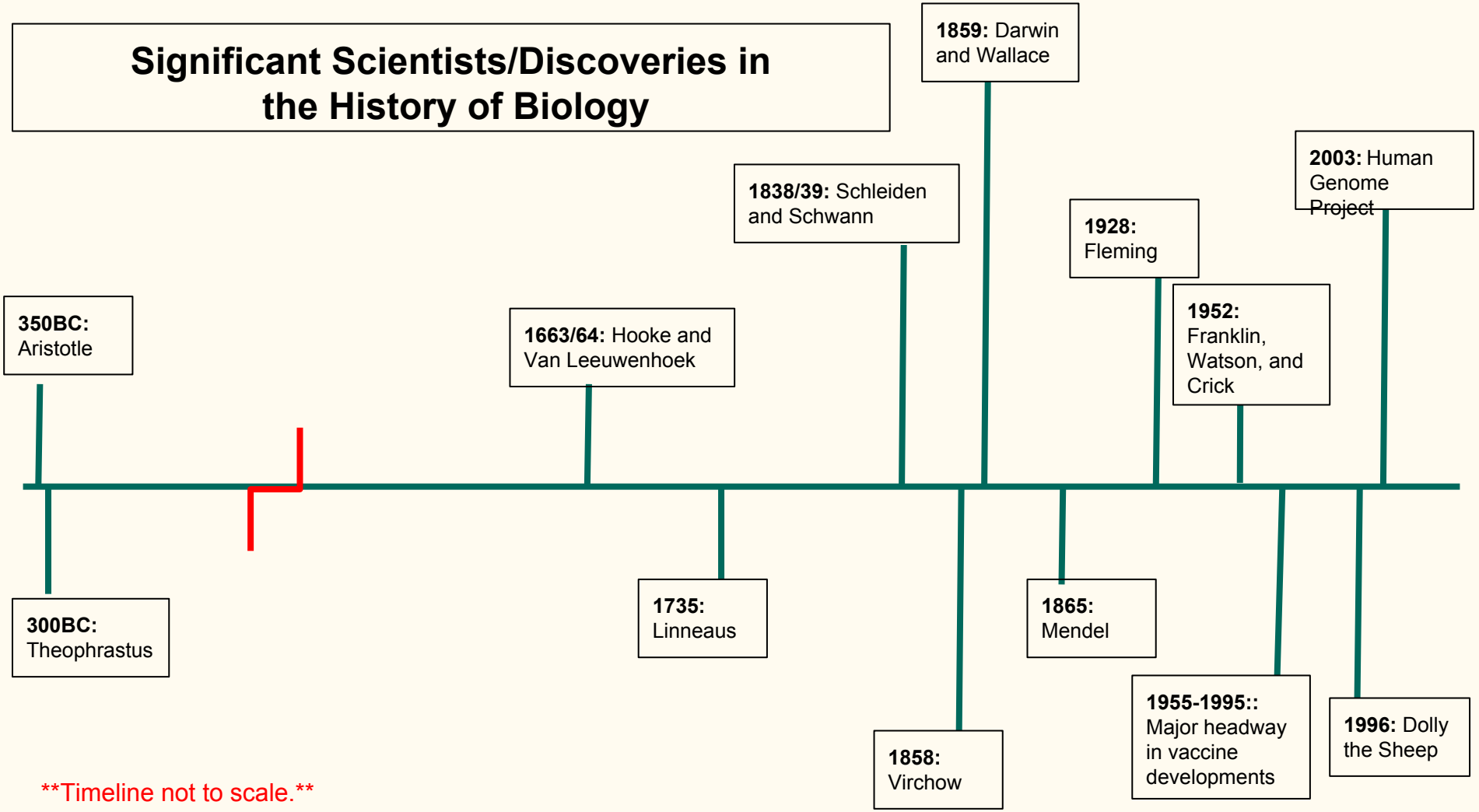
History of Biology

By: Margaret, Megan and Mollie

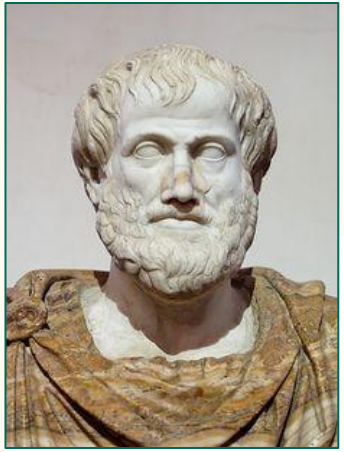
Significant Scientists/Discoveries in the History of Biology



Timeline not to scale.

350 B.C - Aristotle Founds Zoology

- Called the **“Father of Biology”**
- He was the first to use empirical methods and techniques to observe the natural world
- **First to classify organisms by similarities and differences amongst physiologies**
    - Coined the term **“Ladder of Life”**
        - Organisms were classified based off complexity-- with humans at the top of the ladder
- Societal Impacts: Aristotle’s work in zoology and classification paved the way for future biologist such as Darwin and Linneaus



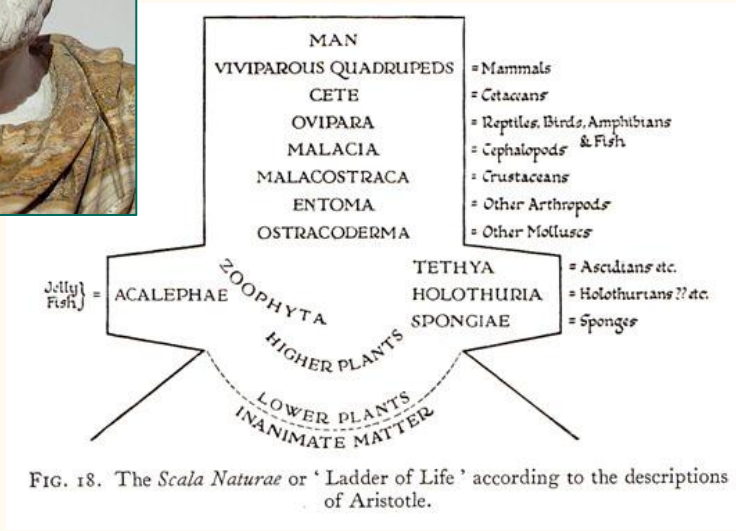
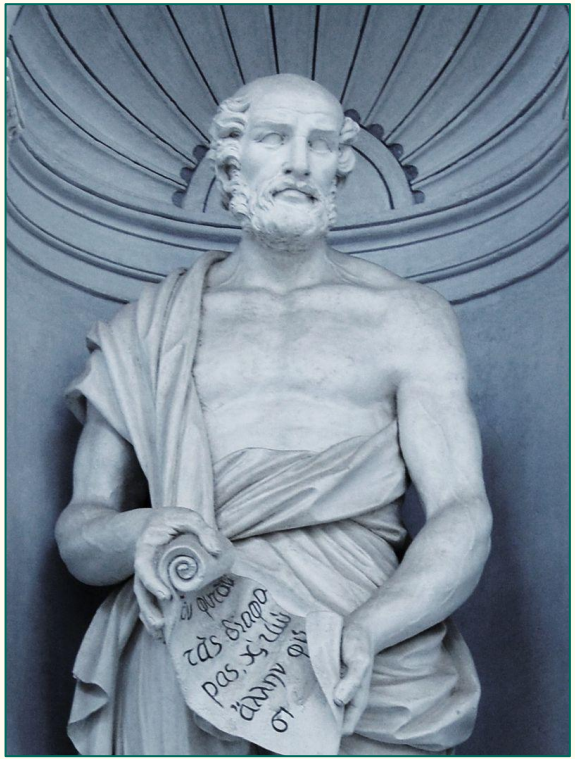
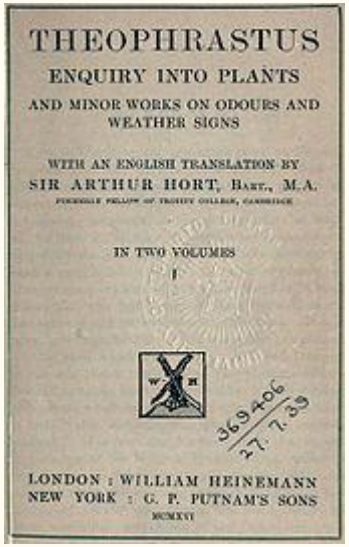


FIG. 18. The *Scala Naturae* or ‘ Ladder of Life ’ according to the descriptions of Aristotle.

300 B.C. - Theophrastus Founds Botany

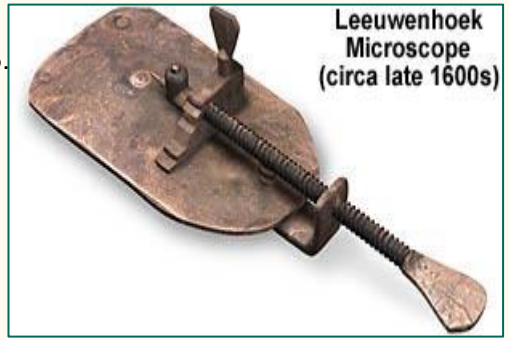


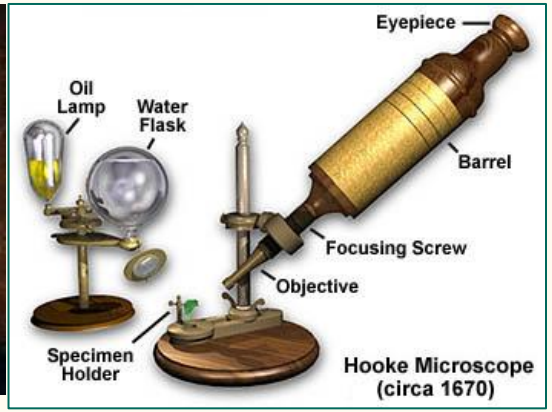
- He was a student of Aristotle's and was coined **"The Father of Botany"** because he provided the first recorded documentation of the study of plants.
- He wrote *Enquiry into Plants* (*Historia plantarum*) and *Origins of Plants* (*Causae plantarum*), the first two publications to ever be written about plants.
- Societal Impacts: In these books Theophrastus classified and wrote observations about different types of plants found at the time. The books also describe plant processes and horticultural and agricultural practices.



1663-1664: The Microscope and Cells

- **Robert Hooke** sees cells in cork using a microscope in 1663.
- He is the first person to ever observe a cell and he described the cells as “pores.”
- Hooke coined the word “cells” even though he did not realize he was looking at plant cells at the time.





- **Antonie Van Leeuwenhoek** improved the microscope in 1664. The single lens microscope he built could magnify about 200 times, which was a significant improvement of the microscope Hooke used that could only magnify 20-30x.
- He was the first to see and describe bacteria, yeast plants, microorganisms in pond water and the circulation of blood corpuscles in capillaries.
- Societal Impacts: Both of their contributions helped begin the discipline of Cell Biology and lead to the Cell Theory.

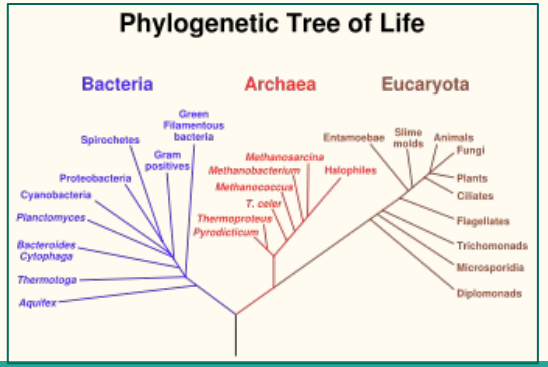
1735 - Binomial Nomenclature Invented

- Linnaeus studied the use of plants, minerals, and animals in medicine
  - wrote an essay on the **classification of plants based on their sexual parts**.

- Linnaeus eventually earned the title of the **“Father of Taxonomy,”** the binomial naming system which he invented.

- A pioneer in the study of ecology, he was one of the first to describe relationships between living things and their environments

- Social Impacts: Linnaeus’ system has helped scientists be able to explain the relationship between organisms and led to a much more detailed classification system of all life.



1858 - Cell Theory

- **Rudolf Virchow** proposed that cells can only arise from pre-existing cells
  - **"Omnis cellula e celulla," all cell from cells.**

- One of the 19th Century's foremost leaders in medicine and pathology; German physician

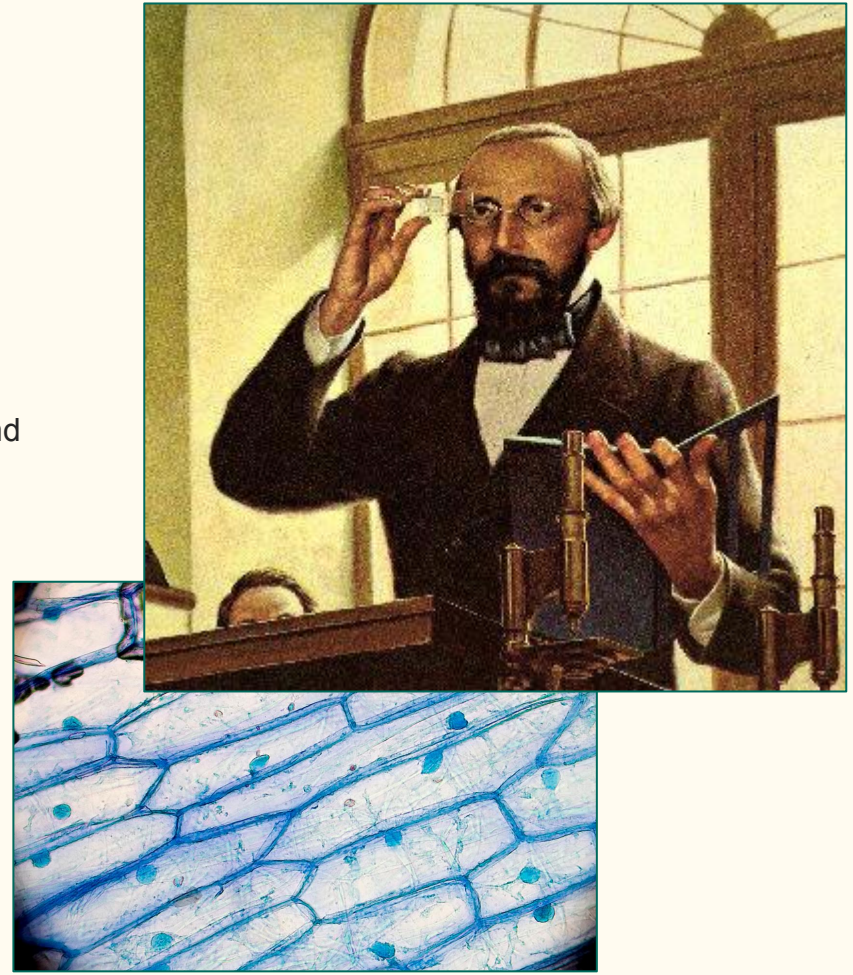
- The **Cell Theory** states that:

  1.) all organisms are composed of cells (**Schleiden and Schwann**),

  and

  2.) cells can only come from other cells (**Virchow**).

- Societal Impacts: The development of the Cell Theory helped to expand the field of Cellular Biology.

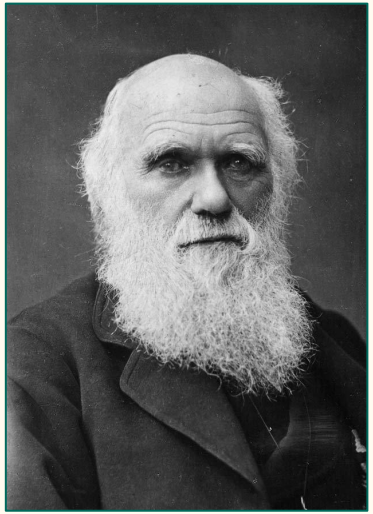


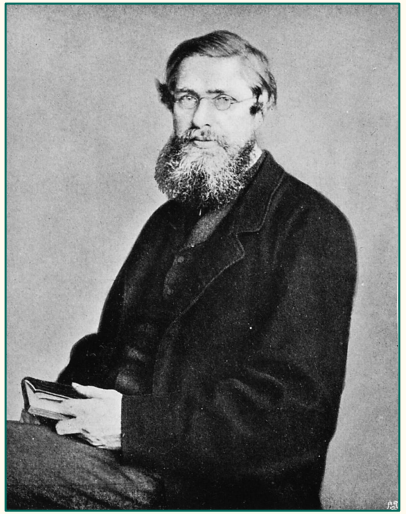
1838-1839: Plants and Animals are Made of Cells

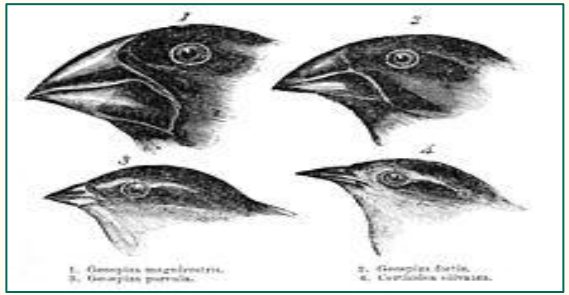
- In 1838, **Matthias Schleiden** discovered that all plants are composed of cells by looking at the tissue of plants underneath a microscope.
- German botanist.

- The next year, in 1839, **Theodor Schwann** proposed that all animal tissues are composed of cells.
- Schwann and Schleiden argues that cells are the elementary particles of life.
- Social Impacts: Schwann and Schleiden's discoveries, along with Virchow, helped to form the lasting three parts of **the Cell Theory** and founded **Histology** (the study of the structure of tissues) by defining the cell as the basic unit of an animal.

1859 - Theory of Evolution







- **Charles Darwin** proposed his **theory of biological evolution by means of natural selection**
  - Darwin noticed subtle differences amongst organisms from across the Earth, along with variances based on location
    - **He believed these organisms all have a common ancestor**
- He believed organisms survived via “natural selection”
  - The survival and reproductive success of individuals best adapted to their environment and leads to genetic qualities best suited for that environment
- **Alfred Russel Wallace** jointly contributed to the theory of evolution by natural selection

- Societal Impacts: Vigorous conflict between creation and evolution in public education, primarily in the United States

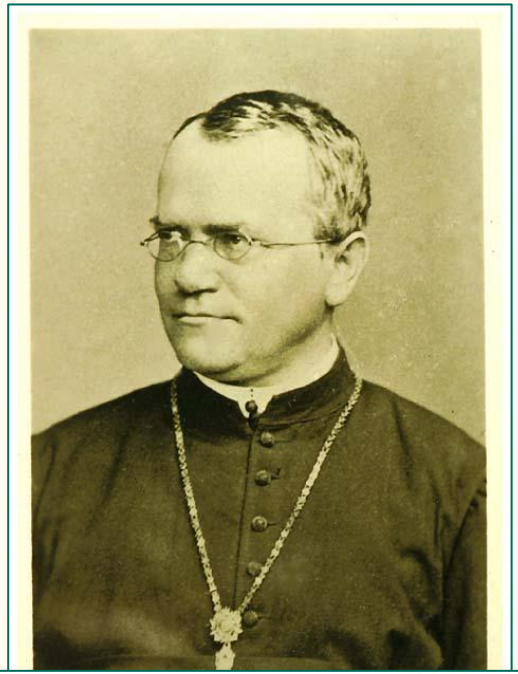
1865 - Laws of Inheritance

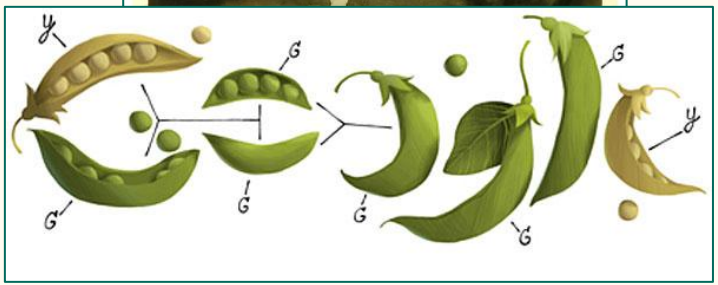
- **Gregor Mendel** demonstrated in pea plants that inheritance follows definite rules.

  a. **The Principle of Segregation** states that each organism has two genes per trait, which segregate when the organism makes eggs or sperm.

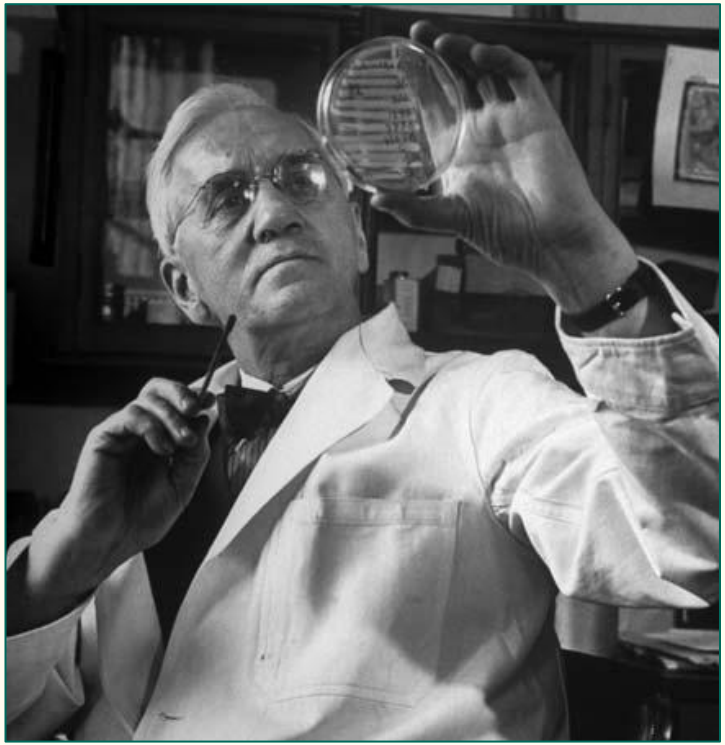
  b. **The Principle of Independent Assortment** states that each gene in a pair is distributed independently during the formation of eggs or sperm. Mendel's trailblazing foundation for the science of genetics went unnoticed, to his lasting disappointment.

- Societal Impacts: Mendel's work laid the foundation for the field of Genetics.





1928 - Discovery of Penicillin

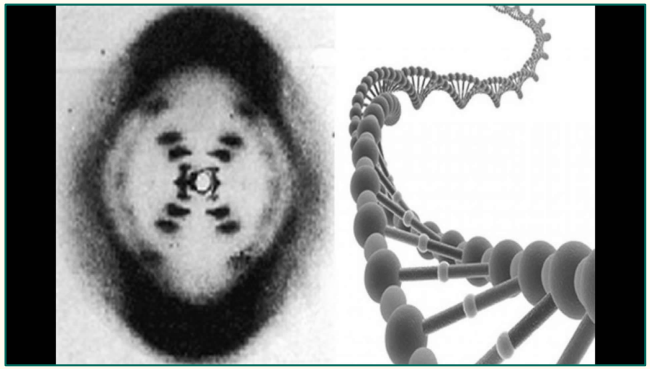


- Before antibiotics, there was no effective treatment for infections
- **Alexander Fleming** accidentally left plates of *Staphylococcus aureus* exposed and noticed the growth of mould
  - Around the mould were circles of zero bacterial growth
    - Called this discovery penicillin
- Fleming, Florey, and Chain did additional tests to mass produce penicillin as a drug to fight off bacterial infections
- Social Impacts: one of the greatest advancements in medicine
  - Fleming discovered bacteria developed antibiotic resistance with too little penicillin or for too short of time
  - Cautioned public about antibiotic resistance

1952-1953 Double Helix DNA Structure Determined

- In 1952 **Rosalind Franklin** observed that DNA is a double helix. She took the first noted photos of the DNA structure using x-ray diffraction and her infamous photo 51 (below) was the image that helped Watson and Crick publish their work.

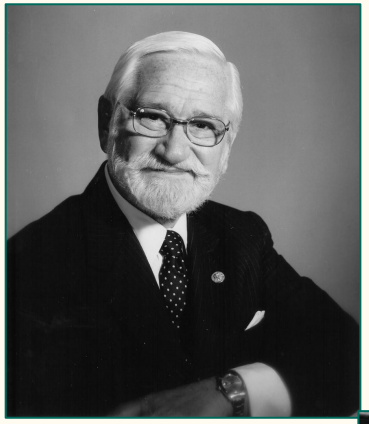
- In 1953 – **James Watson** and his partner **Francis Crick**, who were also working on figuring out DNA's structure at the time, examined the photo which was given to them unbeknownst to Franklin. They went on to publish "their" DNA structure in 1953 and are now credited with its discovery.
- Watson and Crick also published that there was a sugar-phosphate backbone on either side running in opposite directions.
- Societal Impacts: This discovery led to the beginning of our understanding of DNA and the field of Genetics and helped answer the question: "How do living things pass on their traits to their offspring?"



1955-1995: Major Vaccine Developments

- **1955:** Polio vaccine results announced
  - Announced at University of Michigan by **Thomas Francis Jr., MD** (a scientist with extensive experience with influenza vaccines) and colleagues

- **1960: Poliovirus vaccine** recommended by the US Surgeon General to be licensed (created by **Albert Sabin**)
  - This vaccine provided protection against Type 1 poliovirus. Vaccines for Types 2 and 3 would be licensed soon after. A 1963 vaccine would combine all three types.



Albert Sabin

- **1971: MMR combination vaccine** debuts
  - Created by Merck & Co.

Societal Impacts: Vaccinations save the lives of millions of people from preventable death.

- **1986: Hepatitis B vaccine** licensed
  - This was the first human vaccine produced by recombinant DNA methods

- **1995: Hepatitis A** and **Chickenpox vaccine** licensed
  - **Maurice Hilleman** of Merck & Co. creator of Hep A, B, and chickenpox vaccines

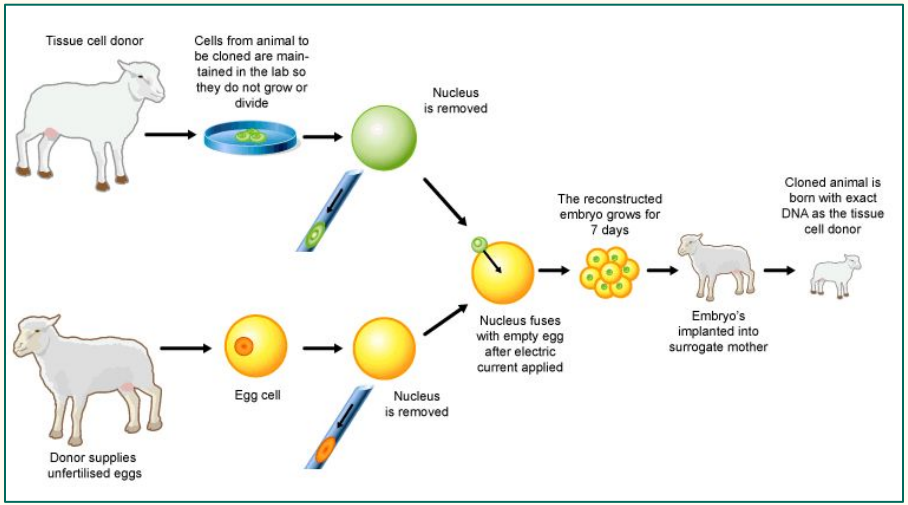
Maurice Hilleman

1996 - Dolly the Sheep Cloned

- First adult mammal cloned
  - Created through a technique called **somatic cell nuclear transfer**
    - A cell is placed in a de-nucleated ovum, two cells fuse, and an embryo develops

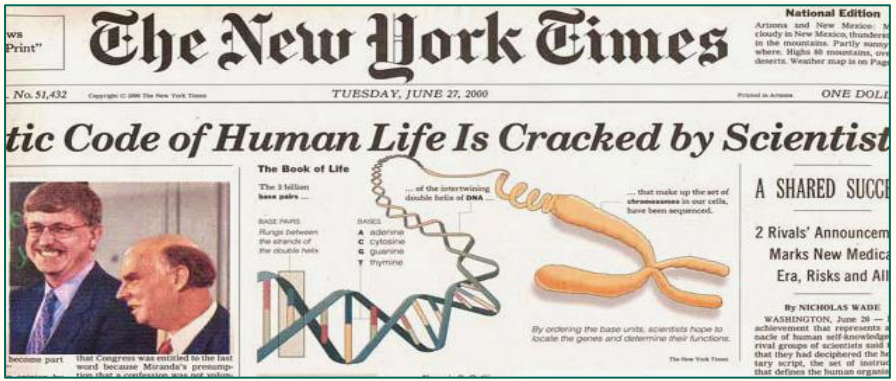
- Pain staking process-- took 277 trials to successfully clone a sheep
- This was the f**irst scientific experiment to demonstrate DNA from adult cells, despite being specialised, can be used to create an entire organism**

- Social impacts:
  - Increased interest in gene targeting
  - Humans and cloning
    - “Picking” characteristics for enhanced children



2003 - Human Genome Project Complete

- Beginning in 1990 it took scientists in the USA and UK 13 years to complete the entire human genome sequence within the Human Genome Project.
- **Scientists discovered that there were ~ 3 billion base pairs and about 20,000 - 25,000 human genes (a lot less than originally thought).**
- Social Impact: The Human Genome Project has allowed scientists and doctors to have a better understanding of the molecular basis and locations of inherited genetic diseases.



The New York Times

National Edition

No. 51,432 TUESDAY, JUNE 27, 2000

tic Code of Human Life Is Cracked by Scientist

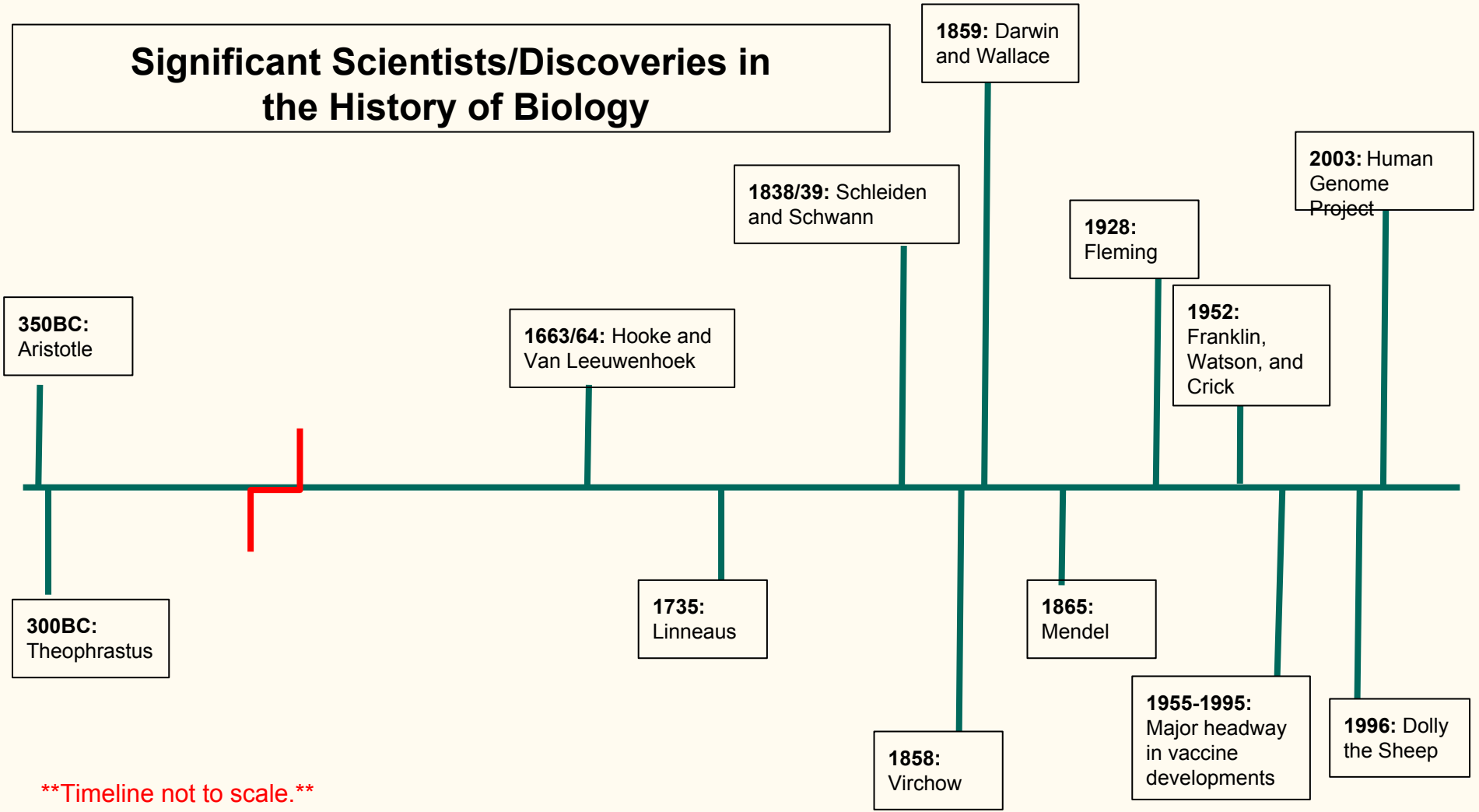
The Book of Life

A SHARED SUCCE

2 Rivals' Announcem Marks New Medic Era, Risks and All

By NICHOLAS WADE

Significant Scientists/Discoveries in the History of Biology



Timeline not to scale.

Women in Biology

Addendum:
—A Timeline of Historic Contributions to the Field of Biology Made by Women

Nettie Stevens - X/Y Sex Determination (1905)

-Stevens observed insects, including mealworms and beetles, discovering that, in some species, chromosomes are different among the sexes. **This discovery was the first time that observable differences of chromosomes could be linked to an observable difference in physical attributes, such as gender.**

-Societal Impacts: Stevens' work laid the foundation for the field of genetics and inheritance.

Alice Evans - Bacteriologist (1918)

- While taking a free course on nature for rural teachers at Cornell University, Evana enrolled and took a basic course in the Agricultural College, which began her interest in bacteriology.
- Later, while holding a prominent position at the U.S. Dept. of Agriculture Bureau of Animal Husbandry, **Evans identified a bacterial infection carried by cows that could cause undulating fevers in humans.**
- Societal Impacts: Her work, and the work of her contemporaries, built upon Louis Pasteur's 19th C. work on pasteurization and pushed for government enacted milk pasteurization laws.

Gerty Cori - Glycogen (1947)

- Received the Nobel Prize in 1947 for **the discovery of the mechanism by which glycogen—a derivative of glucose—is broken down in muscle tissue into lactic acid and then resynthesized in the body and stored as a source of energy (known as the Cori cycle).**

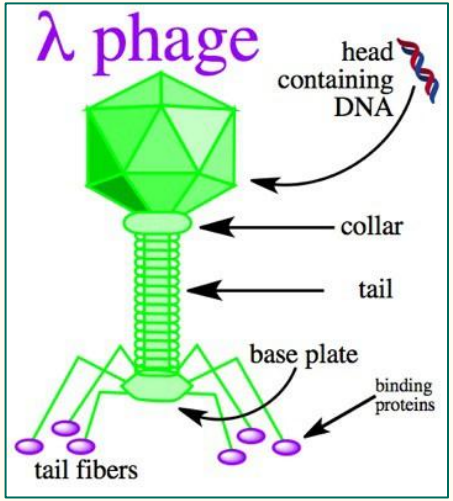
- Societal Impacts: Cori's work helped future scientists understand cellular respiration and energy creation in the cells better, leading to future advances in health care.

Barbara McClintock - Transposition (1948)

- **First to discover transposition**
  - **“Jumping Genes”**
  - **Section of DNA cannot only change position within genome, but can be turned on and off due to certain environmental conditions**
- Makes up majority of the mass of DNA in eukaryotic cells
- Refuted the popular genetic theory of the time that genes were fixed in their position on the chromosome
- Societal Impacts: McClinktock’s findings on gene transposition shifted the prevailing paradigm of the Genetics field.

Esther Lederberg - Lambda Bacteriophage (1950)

- An American microbiologist who pioneered bacterial genetics field
- Her most well-known accomplishment was in 1951, when she was studying E. Coli and noticed some strange streaks on on the mixtures. **She had discovered the *lambda bacteriophage*. She discovered transduction, the transfer of genes between bacteria**
- Joshua Lederberg, her husband, was also a geneticist and unfortunately ended up receiving credit for everything they ever worked on, including a Nobel Prize he won in 1958. He didn't credit Esther with her discovery and she divorced him in 1966.
- Societal Impacts: Esther's work became a model that helps scientists study how viruses work and how genes are regulated and recombined.



Rosalind Franklin - DNA Structure (1951)

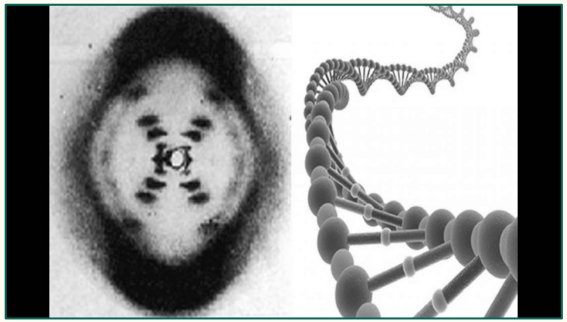


Photo 51

- **Took the first noted photos of the DNA structure using x-ray diffraction.**
- One of her colleagues, whom she had a personality conflict with, gave scientist James Watson Franklin's now famous photo, Photograph 51, of the DNA structure without her knowledge or permission.
- **Watson and his partner Francis Crick**, who were also working on figuring out DNA's structure at the time, used the photo for their DNA structure that was published in 1953 and **are now credited with its discovery.**
- Franklin allegedly never knew they based their work off of her photo and moved on from studying DNA and its structure.
- Societal Impacts: During the last five years of her life Franklin published 17 papers on viruses, and her group laid the foundations for structural virology.

Rita Levi-Montalcini - Nerve Growth Factor (1952)

- 1909 - 2012 Born in Italy into a wealthy Jewish family. Rita Levi-Montalcini considered a career as a writer, but ultimately decided to study medicine.

- **In 1952 she succeeded in isolating a substance harvested from tumors in mice that caused vigorous nervous system growth in chicken embryos.**

- Won the Nobel Peace Prize in 1986 for Medicine

- Societal Impacts: The discovery of what are now known as growth factors has provided a deeper understanding of medical problems like deformities, senile dementia, delayed wound healing, and tumor diseases.

Virginia Apgar - Neonatal Medicine (1953)

-Born in New Jersey, Apgar studied medicine, ultimately ending up as an obstetrical anesthesiologist who made lasting contributions to the field of neonatology.

-She is best know as the inventor of the Apgar score (1953), which is the first standardized method for evaluating a newborn's transition to life outside the womb.

-Societal Impacts: Dr. Apgar's score led doctors to pay greater attention to the infant in the delivery room instead of only attending to the mother.

Lynn Margulis- Endosymbiosis Theory (1970)

- **Proposed the endosymbiotic theory**
  - Origin of cells: says eukaryotic cells evolved from the symbiotic merger of non-nucleated bacteria that existed independently
- In theory, **mitochondria and chloroplasts are descendants of once free- living bacteria**

- Societal Impacts: Lynn Margulis transformed our current understanding of the evolution of eukaryotic cells

Gail Martin - Embryonic Stem Cells (1981)

- Coined the term “Embryonic Stem Cells”
- **Was the first scientist to isolate embryonic stem cells.** She isolated them from a mouse embryo and cultured them in vitro. When injected into a mouse the stem cells formed teratoma tumor which contained normal cells from all three germ layers. This meant that the cells were pluripotent and therefore stem cells.
- Societal Impacts: Martin’s work helped paved the way for the entire field of embryonic stem cell research.

Franciose Barré-Sinoussi - HIV/AIDS (1983)

- Born in Paris, France, Barre-Sinoussi had a humble background and loved nature as a child and spent her school vacations observing plants and animals in the parks.

- Francoise Barré-Sinoussi began working at Paris' Institut Pasteur as a volunteer and received her PhD in 1975.

- In 1983, **Barré-Sinoussi and Luc Montaigner discovered a retrovirus in patients that they later named Human Immunodeficiency Virus (HIV)**, which proved to be the cause of the immunodeficiency disease AIDS.

- Societal Impacts: This discovery has been revolutionary in improving treatment methods for AIDS patients.

Elizabeth Blackburn - Telomerase (1984)

- When cells divide, it is important chromosomes replicate fully and are not damaged
  - Telomeres protect the ends of chromosomes from DNA damage or fusion with neighbouring chromosomes
- **Co- discoverer of telomerase**
  - **The enzyme that replenishes the telomere**
- She was awarded the Nobel Prize in Physiology in 2009 for this research
- Societal Impacts: Blackburn's work revolutionized the field of Genetics

Jennifer Doudna - Gene Editing (2012)

- **Discoverer of CRISPR/Cas9**
  - Gene editing tool by removing, adding, or altering sections of DNA at specific locations

- Societal Impacts: This allows scientists to permanently modify genes in living cells and in the future make it possible to correct mutations at precise locations in the human genome to treat diseases

The Full List of Notable Women in the Sciences

Elizabeth Blackburn and **Carol Greider**- Discovered Telomerase

Barbara Mcclintock - 1902 - 1992 - Genetic Transposition 1983 nobel prize

Jennifer Doudna - 2012- first to propose CRISPR/Cas9 could be used for programmable gene editing

Rita Levi-Montalcini - 1909 - present - 1986 nobel prize for discovery of nerve growth factor

Gertrude Elion - 1918 - 1999 won 1988 nobel prize in physiology

Lynn Margulis - 1970- first to the endosymbiotic theory

Alice Evans - 1881 - 1975 - research bacteriologist discovered brucellosis; Her research led to pasteurization of milk

Rosalind Franklin - 1920-1958

Francios Barre Sinoussi - 1947 - present - helped identify HIV as the cause of AIDS

Dorothy Hodgkin - 1910-1994 - confirmed the structure of penicillin and Vit. B12, was the third woman to win the Nobel Peace Prize; was awarded the prize in Chemistry in 1964

Christine Nusslein-Volhard - 1942-present - research on the genetic control of embryonic development

Nadlini Nadkarni - 19?? - present - Indian-American ecologist/canopy researcher in S. America

Nettie Stevens - 1861-1912 - early American geneticist; X-Y- sex- determination system

Virginia Apgar - 1909- 1974 - designed and introduced the Apgar Score, the first standardized method for evaluating a newborn's transition to life outside the womb.

Gerty Cori - 1947, received the Nobel Prize in 1947 for the discovery of the mechanism by which glycogen--a derivative of glucose--is broken down in muscle tissue into lactic acid and then resynthesized in the body and stored as a source of energy (known as the Cori Cycle).

Gail Martin (alongside Martin Evans and Matthew Kaufman) - 1981- - isolated embryonic stem cells

Esther Lederberg - 1922 - 2006 - created replica plating, a technique for studying bacteria and viruses. She also discovered that bacteria mutate randomly, explaining the resistance that is developed to antibiotics, and discovered the lambda phage virus

Helen Blau - contemporary - researches cell and developmental biology

Clara Barton - Civil War battlefield nurse; founded the Red Cross

Thanks for listening!