Scientific Advances of the 17th and 18th Centuries

Dr. Alan Haffa

Please Silence Cell Phones!

Isaac Newton (1642-1727)

- Invented Calculus (independent of Leibniz)
- Optics and Light: demonstrated that visible (white) light is heterogeneous; prisms separate white light
- Laws of Motion: (1) Every body continues in its state of rest, or uniform motion in a straight line, unless it is compelled to change that state by forces impressed on it (inertia). (2) The change in motion is proportional to the motive force impressed and is made in the direction of the straight line in which that force is impressed (F = ma). (3) To every action there is always an opposed and equal reaction.

William Harvey 1578-1657

- 1628, *On the Motions of the Heart and Blood*
- Galen (Third century Rome: back and forth flow through heart between veins and arteries
- Fabricius and Valves
- Harvey tied off artery and side toward heart bulged; tying off vein, side away from heart bulged. One way circulation. But how?
- Calculated that in one hour the heart pumped three times the weight of a man; heart could not be formed and broken down so fast
- **Hypothesis: there must be invisible vessels through which blood flowed from arteries to veins**

Anton van Leeuwenhoek (1632-1723)

- Earlier microscopes were limited and used imperfect glass
- Using single lenses, small enough to built from flawless glass he could get 200-fold magnification
- Saw blood moving through capillaries! Confirming Harvey
- Saw spermatozoa—raising questions about origins of life
- In ditch water, saw “animalcules,” protozoa—first animals. Invented microbiology.

Robert Hooke (1635-1703)

- Drawings of a bee's stinger, a razorblade, snow crystals, wood, cork and insects.
- Invented word “cell”
- "Next, in that these pores, or cells, were not very deep, but consisted of a great many little Boxes, separated out of one continued long pore, by certain Diaphragms, as is visible by the Figure B, which represents a sight of those pores split the long-ways.”

Microscope and Origins of Life

- Origin of Life and Spontaneous Generation; maggots and meat
- Harvey hypothesized invisible seeds

- Fracesco Redi (1668): Having read Harvey he wanted to test theory
- Test: 8 flasks with meat; 4 sealed and 4 open; What happened?
- Repeated experiment with gauze to allow air, but shield meat from flies; What happened?

Vitalists vs Mechanists

- Mechanists: explain life mechanistically—life subject to laws of nature
- Georg Ernst Stahl (1660-1734): Vitalist, living organisms distinct from inanimate, subject to unique laws
- Germann Boerhaave (1668-1738): the body is governed by the laws of physics and chemistry (Mechanistic)
- Microorganisms as a bridge between living and inanimate for Mechanists; Spontaneous Generation
- Vitalists saw an unbridgeable gap between even microbial life and inanimate matter; Spontaneous Generation impossible

John Turberville Needham (1713-81)

- Testing for Spontaneous Generation
- Heated broth to boiling then sealed in a flask
- Microorganisms grew in a few days
- He assumed the boiling had sterilized the broth; hence, the microorganisms had arisen out of dead material, proving spontaneous generation
- What is wrong with this experiment?

Lazzaro Spallanzani (1729-99)

- Reexamined Needham's experiment
- Longer boil needed to sterilize: boiled for one half to three quarters of an hour and then sealed
- NO microorganisms appeared
- Mechanists: proved that spontaneous generation didn't happen
- Vitalists: claimed that the air contained vital principle and boiling destroyed it
- Issue wasn't settled until 19th century

Carl von Linne (1707-78) Linnaeus

- How to classify life
- Species?
- Based system of classification on sexual organs of plants
- Founder of Taxonomy
- Latin and English names: Homo Sapiens!
- Could the "tree of life" grow? Linnaeus was a creationists and rejected the idea of growth or extinction of species
- Relationships would lead others to speculate on Evolution

Georges-Louis Leclerc, Comte de Buffon (1707-1788)

- Questioned the Age of the Earth—7,000 years to 70,000 years
- Origins of Earth from a Comet striking the Sun; estimated period of cooling
- Change Through Migration
- His ideas though wrong were important because he imagined both Life and Earth having a history

Robert Boyle (1627–1691)

- **Boyle's Law: volume of gas varies inversely with pressure**
- PV=nRT
- P=Pressure
- V=Volume
- n= number of molecules
- R=Ideal Gas constant
- T=Temperature
- Experiment using a bent tube and mercury

Implications of Boyle's Law

- Pressure Cooker
- Temperature can be raised while keeping a constant volume; pressure must be raised
- Water can be raised above its boiling point—thus, you can cook faster or sterilize better

Antoine Laurent Lavoisier (1734-94)

- Theory of combustion: combustion is result of chemical union of burning material with oxygen of the air
- Conservation of Mass in reaction
- Placed tin in a flask with oxygen and heated it
- Increased weight of tin proportional to decreased weight of Oxygen
- Combustion and Respiration: respiration a form of combustion in which oxygen
- Mechanistic Validation: Mouse and Candle—both consume oxygen and are extinguished
- Animals are doing chemical reactions

Joseph Priestley (1733-1804)

- Priestley isolated and characterized eight gases, including oxygen.
- He contributed to the understanding of photosynthesis and respiration.
- Added plants to box with mouse and candle; allowed mouse to live longer

Summary

- Scientific Method changed the way truth was determined: objective and verifiable
- Challenge to religious views about Origins of Life, Biblical Explanation of Age of Earth,

notion of Fixed Species, and idea of Life as Mechanistic rather than Vitalistic

- Microscope led to a revolution in Biology
- Chemistry changed our understanding of Substance: malleable and predictable change