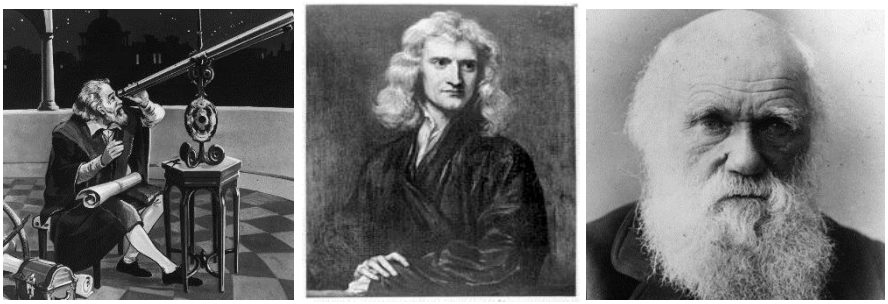
**STS MODULE 3A**

**I. Topic:** Intellectual Revolutions



*Images from www.biography.com, www.catholicbusinessjournal.com*

## II. Objectives

After reading and doing the tasks in this module, you should be able to

A. Explain the scientific theories behind the revolutions in science
B. Discuss the impact of scientific revolutions to society's worldview
C. Name the prominent people behind the intellectual revolutions
D. Identify Kuhn's phases of scientific revolution

## III. Introduction

The previous lessons in scientific and technological developments have shown how changes in science, technology and society go hand in hand. This simple framework enables you to analyze STS issues. When new demands and needs arise from society, it is expected that S & T will step up. When something new is invented or discovered, it is expected that some sort of changes will also manifest in the society. Some changes in science are quite immense that they are called revolutionary. How such process takes place is the focus of this module.

## IV. Discussion

### *Kuhn's Philosophical View of a Scientific Revolution*

Science is comprised facts, laws or principles, and theories. Laws are descriptions of relationships between quantities. A theory on the other hand is a well-substantiated explanation and serves as the foundation of the law or principle. For instance, the kinetic molecular theory simply says that gas particles are in constant motion and exhibits elastic collision. This simple fact explains the following laws: Boyle's Law, Charles' Law, Law of Partial Pressure. This nature of science, being a body of knowledge makes us think that progress in science is simply addition of more facts, laws, and theories. And when the progress is quite drastic, we think of it as a scientific revolution. Thomas Kuhn has different take on this.

Thomas Kuhn (1922-1996) was an American philosopher of science. His views about science contributed much in the development of STS. His most influential book was "The

Structure of Scientific Revolutions". In this book, Kuhn considered revolutions in science as paradigm shifts rather than mere addition of knowledge. He views science as developing in leaps from one paradigm to another. He argued that scientific revolutions go through the following process. First, there is an existing paradigm where the usual scientific activities are done within its boundaries. That was the normal science. What happens next is the anomaly stage. This is the point when data, observations and computations can no longer be explained by the reigning paradigm. This leads to the crisis stage when new methods or approaches tried to explain the anomaly. When these new methods are successful the incubation period follows. This is the period of transition from the paradigm to the new ones. Once the new paradigm has been generally accepted, the paradigm shift is said to be complete. This process could take several years or even hundreds

**The Scientific Revolution in the Middle Age**

In the Middle Age, science revolved around theories that were considered theologically sound by the church. This was the normal science in Kuhn's perspective. One of the scientific theories supported by the church is Ptolemy's geocentrism which puts the Earth at center of the universe. This theory makes a lot of complex calculations and assumptions in reconciling the observable universe then. In 16$^{th}$ century, Nicholas Copernicus (1473-1543) introduced heliocentrism where the sun is said to be the center of the planetary system. This idea did not gain enough support from the scientific community and from the public as well because evidence cannot be provided by that time. Johannes Kepler (1571-1630) found the heliocentric model consistent with his calculations that planets move around the sun in elliptical orbits. Copernicus and Kepler had the right assumptions but they were not able to present a convincing anomaly that would put medieval science in crisis. In the early 17$^{th}$ century, Galileo (1546-1642) succeeded in presenting a concrete evidence that put geocentrism in crisis. Galileo discovered the moons of Jupiter and the phases of Venus. Using his telescope, Galileo observed the motion of the moons around Jupiter. He also observed that Venus went through a full set of phases. These two observations cannot be explained by geocentrism so he proposed that heliocentrism was the real deal. Galileo however could not answer the issue of parallax so his idea of heliocentrism was accepted as hypothetical only. Galileo insisted in his published work "The Dialogue Between Two World Systems" that heliocentrism is the real theory. In the Dialogue his arguments about heliocentrism was pitted against the church teachings. This put him in conflict with the church. He was excommunicated and his book was banned for over a century. In 1992 the Church acknowledged their fault and exonerated Galileo. The tragedy of Galileo became the iconic case of religion against science. The truth however is that the Church itself through its cathedral universities was the primary developer of science in the medieval period. There is independence actually in the study of natural philosophy as long as the scientists do not question religion like Galileo did. The observance of the boundary between science and religion could be the sustaining force behind the scientific revolution. After more than one hundred years, Isaac Newton (1642-1727) provided the mathematical explanation to the planetary motion with his law of universal gravitation. Newton's theory of gravity became the foundation of modern astronomy. Newton's laws of motion were originally introduced to explain the elliptical orbits of planets and all were grounded on the theory of gravity. Newton's ideas completed the shift from faith centered understanding of the physical world to one that is mechanical.

**Darwin's Theory of Natural Selection**

Darwin's theory of evolution by natural selection can be regarded as one of the greatest results of the modern science in the field of biology. Charles Darwin's (1809-1882) study of the Galapagos finches led to the formulation of the theory of evolution. He proposed his theory in his book "*On the Origin of Species by Means of Natural Selection"* in 1859. Darwin's book presented evidence on evolution and suggested a theory on how evolution works. He explained that species came to be through natural selection in which the most adaptable species survived. Darwin's theory of evolution was controversial because it came out at a time when most of the people believed the biblical story of creation. What concerned the Christians largely was the implication of evolution on the religious concept of creation. Darwin, however mentioned little of the human evolution in his book. Just like Galileo, Darwin presented an anomaly to an existing world view of human origins. While modern science had gained ground already during the 18$^{th}$ century, the notion of human creation was still the dominant idea. Many priests, pastors and other religious people condemned Darwin's theory. The Catholic Church however did not have an immediate and direct response to the theory of evolution. In 1950, Pope Pious XII through his encyclical *Humani Generis* affirmed that the theory of evolution and the Catholic faith are not in conflict. This was the first encyclical that directly referred to evolution. The theory of evolution led to a new branch of science called evolutionary biology. At present, there are more people who do not believe in the theory of evolution than those who believe it.

**V. Summary**

The scientific revolution in the medieval age was not all about shift from heliocentric to geocentric model in astronomy. It was more of the change from faith centered understanding of the physical world to an objective one. In biology, Darwin's theory of evolution is quite revolutionary. It has the potential to change societal views as well. The reality however, is that more people still keep a faith centered understanding of their origin. What is clearly shown here is that science does not change people's well entrenched mindset overnight. It is a long process.