Euclid, Archimedes & Ptolemy: Alexandrian Hellenistic Philosophers

This lecture recounts the achievements of the many great minds that called Alexandria home. We will look at Euclid, Ptolemy, Archimedes, Aristarchus, Herophilos, Erasistratus and Eratosthenes.

## The Library of Alexandria's Strengths

As we learned in our lecture on the Library of Alexandria, a great number of features combined to make Alexandria the center of scholarship of the Hellenistic world and beyond. Alexandria was part of a large empire, united by Greek language, Greek writing and Greek culture. Though the empire collapsed, its common Greek language remained, allowing scholars from all over the known world to learn from one another.

Alexandria was a particularly good place for this sort of scholarship to occur, because the banks of the Nile provided an excellent place to grow papyrus, a plant that could be made into a fantastic paper. The abundance of papyrus allowed the Ptolemaic kings of Egypt to collect all the writings available at the time and house them in the largest library in the world, the Library of Alexandria. It was at this library that the greatest minds of the age came to study and teach.

Alexandria was home to many great philosophers over the years. We cannot possibly cover all of them, though I do wish, at least, to touch on some of the most important.

Euclid's Geometry

The foremost of these is certainly **Euclid**. Euclid made some major contributions to the field of mathematics. He invented the **mathematical proof**, which remains the basis of modern arithmetic. He also did some serious work with prime numbers
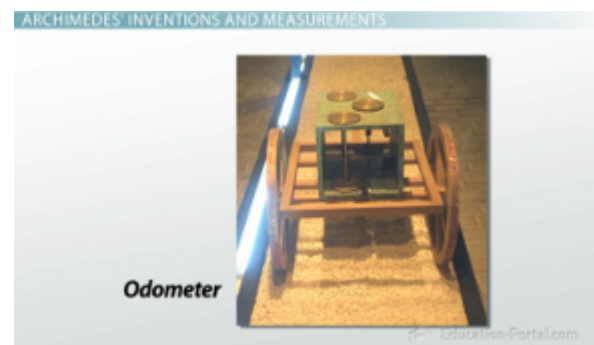
Archimedes developed the odometer to measure distances

and factorization. Yet his biggest contribution was in the field of geometry. Pretty much every rule you learned in geometry class was either invented or recorded by Euclid. For this reason, he is considered the Father of Geometry.

Archimedes' Inventions and Measurements

Our next Alexandrian philosopher is **Archimedes**. Archimedes made a name for himself with his many inventions, including the water screw, which could draw water upward; an odometer for measuring distances; the block and tackle pulley system, which harnessed leverage to allow a single man to lift far more than he could unaided and even a heat ray, designed to sink ships from a distance. Archimedes was also the first to come up with a good estimate for pi.

Yet, Archimedes is most famous for discovering a method for measuring the volume of irregular solids. According to the story, King Hiero II had a crown made by a goldsmith, but he was not sure if the goldsmith had made his crown out of pure gold, or if he'd mixed in other metals. The density of gold was well known, but at that point in time there was no way to find the volume of an irregularly shaped thing like a crown. Archimedes was pondering this problem in his bath, when he noticed that his irregularly shaped body made the water in his tub rise in a very regular and easy to measure fashion. In his excitement he leapt from the tub, forgetting to dress before running into the street crying, 'Eureka! Eureka!' which means, 'I've found it!'

Herophilos was one of the first doctors to assess heart rates

Other Famous Alexandrian Scholars

Some other notable Alexandrian scholars were **Herophilos**. He was the first person, on record at least, to systematically dissect human cadavers and record his findings. His methods were the closest thing to science of the age, being based on experimentation and rigorous record keeping. Herophilos was one of the first doctors to measure the heart rates of his patients as part of his diagnosis.

Another great Alexandrian anatomist was **Erasistratus**. Erasistratus disagreed with the great minds of his time, who claimed that the heart was the center of sensation. After dissecting the heart and taking copious notes, Erasistratus determined that the heart was merely a pump and identified the brain as the center of the nervous system. Up until this point, the general opinion was that the brain was the place where the body cooled its blood.

Returning to mathematicians, we find **Aristarchus**. Aristarchus was the first to propose a **heliocentric universe**, in which the Sun occupied the center of the solar system. He came to this conclusion when he noticed that the position of the planets relative to the stars seemed to change at different seasons. He concluded that the best explanation was that his point of observation was moving. You can see what he was thinking with a simple example, what I call the Apollo 13 experiment.

Close your right eye and hold up your thumb until it covers the planet on the screen. Now, close your left eye, and open your right eye. Now you can see the planet! So, what happened? Did the planet move? No, your perspective moved.

This phenomenon is called **parallax**, and it works on a larger scale just as well as on a smaller one. By measuring this parallax, or change in relative position, Aristarchus posited that the universe was much larger than had been imagined. Since the planets show parallax, but the stars show no parallax at all, the stars must be incredibly far away. Aristarchus' work would inspire later astronomers to understand the true nature of the solar system and the universe.

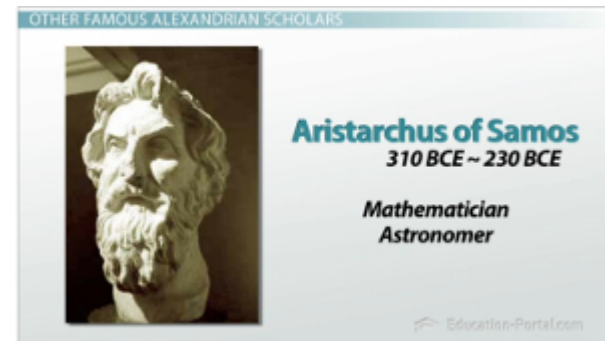Another amazing Alexandrian thinker was **Eratosthenes**. Eratosthenes was the first to accurately measure the size of the Earth. He measured the shadows in wells during the summer solstice to estimate the circumference of the Earth at 39,690 km, an error of less than 2%! It is worth noting this experiment would have been impossible without the extensive astronomical records available at the Library of Alexandria.

Aristarchus of Samos was the first to suggest a heliocentric universe

Ptolemy

But the apex of all of this scholarship was **Ptolemy**.

Ptolemy took mathematics to new levels, creating mathematical solutions to some rather tricky problems. The first was how to represent a spherical Earth on a flat piece of paper. To overcome this, Ptolemy improved upon the art of map projections, creating some of the most accurate maps of his time.

A bigger problem was the problem of retrograde, or backward, motion among the planets. After reading centuries of astronomical observations, Ptolemy noticed that in their orderly dance across the heavens, planets sometimes seem to stop and turn the other way. Now, we today know that this is because we, in the Earth, are rotating, and when we pass those planets on our own orbit around the Sun, they seem to go backwards, just like when you pass a car. It's going forwards, you're going forwards, but the car

seems to be going backwards as you pass it. Ptolemy thought that the Earth was in the middle of the universe. He should have listened to Aristarchus. To explain this model from a geocentric perspective, Ptolemy came up with something called **epicycles**, in which planets move in little teeny circles as they go on their larger orbit around the Earth.

With this idea, Ptolemy came up with an incredibly complex model of the solar system. Though his model is totally wrong, the math is strikingly accurate nonetheless. Even today, Ptolemy's projections on planetary positions are only off by a few degrees, an amazing feat even by modern standards.
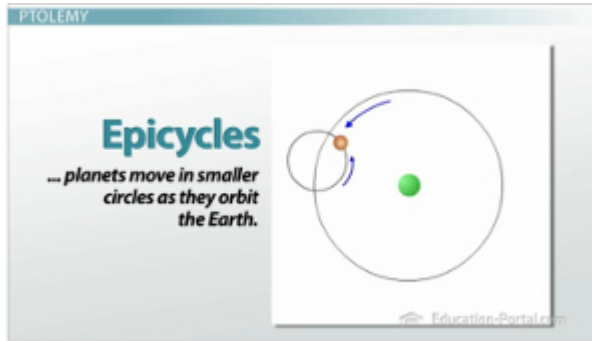
Ptolemy proposed that planets follow epicycles as they orbit Earth

Lesson Summary

The philosophers of Alexandria made huge breakthroughs in science, math, medicine, astronomy, and engineering. **Euclid** perfected geometry. **Archimedes** invented half a dozen tools and methods we still used today. **Herophilos** and **Erasistratus** applied scientific methods to human anatomy, making medical observations that would not become common knowledge for thousands of years. **Aristarchus** was likewise way ahead of his time when he posited that the Earth rotated around the Sun and not vice versa. **Eratosthenes** measured the Earth to within a few hundred miles. And **Ptolemy** created a completely inaccurate model of the universe, which nevertheless could predict the positions of the planets and stars even today.

These feats of genius were not created in a vacuum. Amazing as the Alexandrian philosophers were, none of their discoveries would have been possible without relying on the work of those who came before them. These days we take it for granted that everything ever written is accessible online. Yet thousands of years ago, this sort of access to the wisdom of the ages was rare indeed, only to be found in a few places in the world. The Library of Alexandria was one of those places. After the library burned, it would take a thousand years and the invention of the printing press, which allowed for the easy transfer of information, for Western scholars to reach the lofty heights of knowledge achieved at the Library of Alexandria.

Lesson Objectives

After watching this lesson, you should be able to:

- Understand the significance of the Library of Alexandria as it relates to Hellenistic scholarship

- Identify and describe the achievements of: **Euclid**, **Archimedes**, **Herophilos**, **Erasistratus**, **Aristarchus**, **Eratosthenes** and **Ptolemy**