The Presocratics: Crash Course History of Science #2

Crash Course: History of Science
https://youtube.com/watch?v=epCOGAa7tRQ
https://nerdfighteria.info/v/epCOGAa7tRQ

===== (00:00) to (02:00) =====

Long ago, some philosophers worked very hard to separate myths from what they actually knew about nature. Thales theorized that everything in the world is made of water. Pythagoras was a mathematical-mystical vegetarian. And Democritus, we all know and love as the Atom Guy... Meet the Presocratics!

[Intro Music Plays]

The Presocratics were named for their leader, Presocrates. That is a joke! They were several different philosophers who lived before Socrates. Why start with the Presocratics? Since people have systematically made knowledge about the world for millennia, there's no single starting point. But a convenient place to get our footing is ancient Greece.

These Greeks were the cornerstone of scientific inquiry in western Europe. THeir theories had a terrific run. Can you imagine coming up with a question about nature that puzzles people for more than two thousand years? I can't even decide what to have for breakfast.

A more practical reason to put on our thinking togas is that the ancient Greeks left behind sources. Writing stuff down makes history possible and here's a pro tip: if you want to be remembered in two thousand years, keep a diary! Preferably on vellum with metallic ink. Also, get super famous sot aht your students make plenty of copies.

Not all of the people we think of as "ancient Greeks" actually lived in Greece. Their culture stretched across a prosperous region called Ionia. And they weren't as ancient as soem even ancient-er Greeks. We typically date ancient Greece as starting around 800 BCE, after the fall of the Mycenaeans. Those are the dudes who burned down Troy because one of them got dumped. Zero chill.

"Ancient" Greece ends witht he Roman conquest in 146 BCE. We're focusing on a science-dense period from around 600 to 400 BCE. These Greeks live in small towns and are very comfy out at sea. They trade and fight with each other a lot, and they sometimes have to deal with invading Persians.

===== (02:00) to (04:00) =====

They worship nature, but their land is deforested and eroded. They love setting up new colonies all along the Mediterranean and the Black Sea. There is no public support for anything like modern science. There aren't even schools in which to study science.

The Greeks practiced natural philosophy, meaning "self-conscious inquiry into nature." A lot their philosophies were about answering our first running question here on History of Science - What is stuff? I mean, really?

If you watched our first episode, you'll know that we can divide science into both a body of knowledge and a set of methods. When you examine the work of these Pre-Socratic philosophers, you can see two important things.

First, they weren't scientists in a modern sense. They didn't make detailed, accurate knowledge of nature based on observation. But they did come up with theories that tried to account for why stuff is the way it is.

In their wonky-sounding theories, we still find many of the themes that would drive centuries of further inquiry - the divide between the abstract and material, or identifying the smallest possible particle of stuff.

Second, as these natural philosophers tried their best to separate myth from truth, they developed first drafts of many of the methods we still use and value today.

Natural philosophy became a quest for abstract knowledge. This is important because it means the Pre-Socratics started making general claims about the real world - laws that would apply in every situation, not just specific instances.

The Pre-Socratics also developed "schools of thought" that spread their ideas around geographically and down the centuries. These weren't physical schools, they were groups of teachers and students who thought about the same problems.

One of the reasons we know about these schools of thought is because they operated as individuals who took credit for their ideas and whose names were passed down. This practice differed from many other cultures of inquiry and became a foundation for how Europeans later systematically made knowledge.

But the big method of knowledge-making here, and the one that we're going to focus on, was rational debate. Between all those schools and individuals and abstract theories, there was a lot of disagreement.

===== (04:00) to (06:00) =====

To convince people they were right, a natural philosopher had to use reason, logic, and observation to attack the wrong-seeming theories of others and bolster his own awesomeness.

In fact, some historians argue that there's a link between rational debate about political constitutionality, or how humans should govern themselves, and rational debate about the constitution of nature, or how the world governs itself.

Now there are more Pre-Socratics than we could possibly mention so here are a few highlights. This is our rogues' gallery of natural philosophers who all had their own theories and they argued - they rationally debated themselves into the history of science.

The first European natural philosopher whose ideas survived down to the present was Thales: the first individual known to have proved a mathematical theorem - Thales's theorem. In fact, early historians attributed lots of firsts to Thales making it hard to tell exactly what he really accomplished. Regardless, being the first at a whole way of doing thought is pretty unusual.

Thales set the natural world off as separate from the divine. For him, the world was something comprehensible by the powers of the human intellect. It became an object, a thing like other things. This meant leaving the gods out.

For example, Thales held that wind, not a god, caused the Nile to flood. This was a general natural explanation for a phenomenon. Thales was not, however, irreligious. He believed that all things have a god or a soul within them.

Thales was also the founder of the first European school of philosophy - the Milesians. The Milesian school was known for its theory of matter - a theory of stuff. This theory held that water was the primary substrate or the most basic element. The Earth floats on water like a ship. Earthquakes happen when the water rocks back and forth. The soul of things may have not been material, but their stuffness was water. We'll come back to this essential dualism of soul versus matter in future episodes.

===== (06:00) to (08:00) =====

[Later plato and aristotle were dismissive of theles and part of their argument] was that thales once predicted an upcoming harvest to chord the market on the olive oil using his philosophy for personal gain. Is that okay? Depends on who you ask.

Thales' star student was Anaximander. He's thought to have been the first european philosopher to write down his own ideas. Like thales, anaximander believed that nature is ruled buy discoverable laws, but anaximander rejected thales' watery universal substrate proposing instead, a formless initial state called the apeiron. Anaximander proposed that this primal formlessness would then devolve into opposite properties that could be experienced, like hot-cold, wet or dry, heavy-light etc.

Anaximander worked in astronomy, geography, and mathematics. One of his contributions was introducing the gnoman, the part of the sundial that casts the shadow degrees. These had already been used in china for two millennia. The gnoman was good for more than just telling time. It helped people better understand the movement of the sun and it helped anaximander develop a model of the cosmos that envisioned heavenly wheels punctured by holes letting light through - One of our earliest examples of natural philosophers trying to conquer the "where are we" question.

The last great thinker associated with Milesians was empedocles, who was probably also influenced by pythagoras and Parmenides. Almost every greek philosopher had a book called "On Nature". It's super confusing. In empedocles on nature, he put forward the theory of the 4 classical elements: earth, air, fire, and water; mixed by two forces - love and strife. While this theory, of course, seems hopelessly misguided now, remember that simply by asking what is stuff, the milesians were moving away from mythology and toward modern physics.

Probably the presocratic philosopher most well known today is pythagoras. That triangle guy! Pythagoras studied the philosophy of the milesians, but, he was a more mystic thinker. Which is a nice way of saying pythagoras was a cult leader. He believed in reincarnation and outlawed beans, seeing them as impure, probably.

===== (08:00) to (10:00) =====

Historians love to debate the bean thing. At least we're pretty sure he was a vegetarian. How can you be a vegetarian without beans? Pythagoras was focussed on the pure dovetails, the fact that we think of him as having introduced the notion of idealism to science. Idealists generated abstract models of perfect stuff. This was unlike milesians, who were materialists. They started theorizing about actual stuff. In terms of math, pythagoras's idealism meant a shift from practical arithmetic inherited from egypt and Mesopotamia to a new pure geometry.

For pythagoras, numbers were not just a way of counting stuff. They were sacred. Pythagoras loved whole numbers. He hated irrational numbers such as the square root of 2. He called the square root of 2, the alagon (?), or the unutterable. To even know that irrational numbers existed, you had to join the cult of the pythagoreans and work your way into the innermost circle. This is so great! (Hank laughs)

For our purposes, the thing that pythagoras added to science is the role of the mathematical proof. Egypt and babyloneans knew about the pythagorean triplets, that is like the whole number solutions to the pythagorean theorem. That was useful. A practical guide that could be implemented by ancient engineers. But pythagoras understood it and proved it in a purely mathematical abstract. With pythagoras, creating an elegant abstract proof became a model for justifying a new claim to knowledge.

Another major thread in greek thought before socrates was the atomism. The theory that the world is made of particles that you can't divide any further. This was associated with Democritus, who made heavy use of rational debate through dialogues - our wonder of this period. For this, he is the star of this episode's thought bubble.

Democritus held that everything is made of atoms - indestructible, uncreated, always in motion, and infinite in number; and they came in all kinds of shapes and sizes. In his focus on matter, democritus was a materialist, like the milesians.

===== (10:00) to (12:00) =====

He's even credited with holding a bottle of air underwater to show that air is made of stuff. Thus giving rise to the experiment as a way to illustrate a theory. Still, democritus had a lot to prove. He would ask "what is air?" And people would be like "nothing, democritus!" and that's when he would say, "that's where you're wrong!"

Most famously democritus argued against other theorists, Parmenides, and Zeno, using something that we call the Void Hypothesis.

Democritus was like - "Everything is made of little indivisible bits of stuff. I call them atoms."

And Zeno is all "but Democritus, my friend, what is between two atoms?"

Then democritus says "Nothing. Between the atoms, there is only, a void."

And then Zeno replies, "you're caught in a paradox, friend. If everything is made of atoms and the void is a thing, then the void is made of atoms. But then, what is between the atoms of the void?" And then, presumably Zeno dropped the 450 BCE equivalent of the mic and the crowd went wild!

Thanks thought bubble!

This was rational debate. This particular debate would go on for centuries. But more importantly, the structure of the dialog, the celebration of rational debate as almost a sporting event for these nerds, was a new and valuable way to analyze our universe. This debate is just one example of how the presocratics elevated being curious about the world into natural philosophy.

It's important to remember that the natural philosophers of ancient greece live in a different world, both physically and socially from that of like jeopardy and GitHub. But the way that these group of thinkers framed problems about stuff, change, nothingness, mathematical elegance, perception, truth, and the cosmos has echoed across the centuries.

Next time, we'll watch plato and aristotle duke it out over idealism and empiricism. It's gonna be a throwdown for the ages!

Crash Course History of Science is filmed in the Dr. Cheryl C Kinney studio in Missoula, Montana and it's made possible with the help of all of these nice people and our animation team is Thought Cafe.

===== (12:00) to (12:32) =====

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