Simple and Detailed Science Timeline of the Universe

One book I enjoyed when I was younger was Neil DeGrasse Tyson's “Astrophysics for People in a Hurry”. I have a strong nostalgia for this book. There have been a lot of new discoveries since that book and though it is for people in a hurry some of the ideas are confusing to people who aren’t aware of specific physics concepts. I am going to make a super simple video version of the scientific timeline of the universe, from Time Zero to the Time of Life on Earth. This document is a clean detailed version of the timeline of the universe.

0. Time Zero
1. Planck Era
2. Grand Unification Era
3. Inflation Era
4. Electroweak Era
5. Quark Era
6. Hadron Era
7. Lepton Era
8. Nucleosynthesis Era
9. Photon Era
10. Recombination / Decoupling
11. Dark Ages
12. Reionization Era / Galaxy and Star Formations
13. Our Solar System Formation
14. Life on Earth

The Beginning Preface

We don’t even know if the Big Bang was the true beginning. It is still in speculation and we have no way currently to figure out how to look into an earlier time than our marked t=0, time zero.

0. Time Zero, t=0

At time zero all space, matter and energy was contained in a volume less than one trillionth the size of a pinpoint. This origin point was so hot that all the forces of the universe were unified. The source of the point is unknown. From this point it expanded.

I was wondering how scientists came to the conclusion that all things were at a volume of less than one trillionth the size of a pinpoint so I researched it.

We don't know. The math at t=0 is broken because it is undefined; the math outputs 0 size and infinite density. To wrap up time zero, through a math lens, the universe was at infinite density and size 0. Through a speculative physicist’s lens the universe was all one hot dense state.

Now before we move on I also wondered: why wasn't all this mass at this density a black hole? And that is because a black hole needs a difference in density. Everything was the same density everywhere so there was no difference, no steep slope for the matter to fall into.

1. Planck Era

This is the era from t=0 to one Planck Time unit. One Plank time is 5.4*10^-44s. It is found from Planck's calculation using the three constants, G gravity constant, h planck's constant and , c the speed of light.

This is the closest our physics can get to the beginning of time. This is such a short amount of time from the initial time zero that we cannot comprehend properly. I'll show the expanded version of it on the screen. As we talked about earlier in the super simple timeline, the size of the universe would be around the size of a red blood cell at this time.

Now just a note, every era is separated by time and temperatures. Time and Temperature are locked together in a relation. Temperature drops in proportion to the inverse square root of time

2. Grand Unification Era (GUT)

This era spans from one Planck time to 10^-36s. Speculating on the conditions of this event, scientists think that gravity separated from the other forces as the temperature of the universe dropped. With this drop in temperature elementary particles form.

3. Inflation Era

The universe cools off enough for the strong nuclear force to separate from the unified forces. Then we get a rapid inflationary era and the universe jumps to the size of an apple. This rapid inflation is caused by the separation of the strong nuclear force from previously unified forces.

4. Electroweak Era

At this point the unified Electroweak forces break into electromagnetism and the weak nuclear force. The conditions are cool enough for the higgs field to turn on. With this a large number of Higgs bosons and other bosons form and this allows for particles to have mass.

5. Quark Era

At the start of the era the temperature was cooling down to 10 quadrillion degrees. With this condition, quarks, electrons, and neutrinos were able to form. With every quark there is an antiquark partner. The quarks annihilate the antiquarks on collision but there is a surplus of quarks that will be leftover to eventually make matter later down the road.

6. Hadron Era

Then the universe continues to expand and cools to 1 trillion degrees. This starts the Hadron Era. The quarks combine to form hadron particles; they become either protons or neutrons. The hadron particles have antihadron counterparts formed as well, called antiprotons and antineutrons. There is a continuous breaking and recombining of the particles because of the extreme heat. When the hadrons combine with their partners they eliminate each other and photons or light energy are created in their conversion. Most of the particles combine and there is a small amount of hadrons left. There was one hadron left over from every billion annihilation and conversion taking place.

At the end of the Hadron era the universe was one second old and it was 10 billion degrees.

7. Lepton Era

The Lepton Era is very similar to the hadron era. The temperature does continue to cool. This time around the leptons or, as we usually know them, electrons and antileptons or positrons are constantly colliding and destroying each other by converting into photons. Then the colliding photons are combining and creating electron-positron pairs. The clash continued like it was in the Hadron Era but with different particles. Most of the mass of the universe at this point is from the leptons. There are still hadrons floating around from the leftover of the annihilations from the Hadron era.

The slight imbalances of matter and antimatter from these last three eras are the reason that we have matter today.

8. Nucleosynthesis Era

Nucleosynthesis Era happens between 3 minutes to 20 minutes from the big bang. The temperature falls to about a billion degrees. Atomic nuclei form as protons and neutrons are able to fuse together. At the 20 minute mark the fusion stops due to the cooling temperature.

9. Photon Era

Now we are around 3 minutes in from time zero. The temperature of the universe cools to about a billion degrees. Now atomic nuclei can form as protons and neutrons fuse together stably. Then around 20 minutes the temperature has dropped as to where the fusion cannot happen anymore.

10. Recombination/ Decoupling

Now a lot of time passes and there is a gradual cooling. 380,000 years pass by. The universe falls to around 3,000 degrees. Electrons now bind to atomic nuclei and create simple atoms. The universe for the first time becomes transparent and light can spread throughout the universe. This initial decoupling moment is the formation of the cosmic radiation background. At the end of this era there is a fog of atoms consisting of around 75% hydrogen, 25% helium and a tiny amount lithium.

11. Dark Age

Now until 150 million years is the Dark Age. The light from the cosmic radiation background from the decoupling era slowly red shifts out of visible light energy from the expanding and cooling universe. Photons still exist but everything gets dark again. This era is very low energy and the universe is dominated by dark matter, which we still know little about.

12. Galaxy and Star Formations and Reionization

Gravity starts to bring parts of the big fog together. The pockets of gas in the universe start to get denser and denser. As the clouds get denser the gravity increases the cosmic gas starts to collapse into itself and it is hot enough to trigger nuclear fusion and the first primordial stars form. These stars are much larger and have much more mass than the Sun in our solar system. These early stars are “metal free” stars, they burn out quickly and explode into supernovas. These early stars give way to subsequent stars for many generations. And with the generation of the stars, galaxies form around them at the same time.

The first starlight was mainly ultraviolet light and it did not reach far due to the dense gas cloud surrounding the stars and galaxies. While the galaxies and stars were forming we also saw the formation of massive black holes at the centers of galaxies. These active black holes are called quasars and as they are heating up and bringing in more mass there is an intense amount of radiation given off of them. The radiation from the forming of these quasars and the ultraviolet from the stars caused the universe to reionize neutral hydrogen atoms to ionized plasma. With the reionization the new light from the stars travels throughout the universe.

13. Our Solar System

The solar system we live in was formed around 4.5 billion years ago or 9.3 billion years from the big bang. Our sun is much different from the first stars. It has incorporated the debris of many older generations. It is much smaller in size as well. Our sun is technically a yellow dwarf. Its diameter is around 864,000 miles across. It is an average size compared to the stars in the universe we see in the present.

14. Life on Earth Formation

Life on Earth we guess started around 3.7 billion years ago. The Earth was somewhere between 300 to 800 million years old when scientists thought that life could have started.

I think this is very important to know that there are levels to the verification of each step. The earliest verified physical observation is at 380,000 years when the universe’s first stable atoms formed and photons became untrapped and light started to travel through the universe. This was discovered in 1965 and was verified with NASA’s COBE satellite in 1990.
Then the earliest experimental evidence is at the 1 microsecond from the beginning where in particle colliders we recreated the conditions of the early universe.
Then the earliest mathematically described point on this timeline is one planck time, which is 5.4*10^-44s. This is the farthest back we can go before our physics break down.
So it's good to know that Big Bang theory is pretty on point until we get to these different evidence boundaries.

As I was researching I came across a couple contradictory numbers in different timelines. This is because we keep on making new discoveries that change the numbers. Science is not an absolute truth but a tool to find a close approximation to the truth. So even this video in some dating or information could be outdated in 10 years, maybe less, probably less.

My Youtube Video: https://youtu.be/3oYBHT8WW_U

Readings:
Neil Degrasse Tyson, Astrophysics for People in a Hurry, Norton, 2017
Roger Penrose, The Road to Reality, Vintage, 2020

Websites:
NASA https://science.nasa.gov/universe/overview/
PhysicsoftheUniverse: https://www.physicsoftheuniverse.com/topics_bigbang_timeline.html
Pdg: https://pdg.lbl.gov/2025/reviews/rpp2025-rev-bbang-cosmology.pdf
Plank Era Article:
https://www.astronomy.com/science/the-planck-era-imagining-our-infant-universe/

Images:
Nasa Big Bang: Universe_History_2.png
Roger Penrose Pinpoint:
Planck Length: plancklength.png
Planck Time: planck-time-equation-with-caption2.png
Planck Equations: screenshot-2019-03-02-at-09.18.56.jpg

Scientific Citations:

Planck Time / Planck Scale (Untestable at Current Energies)

Planck, M. (1899). Sitzungsberichte der Koniglich Preussischen Akademie der Wissenschaften zu Berlin, 440-480. Original derivation of the Planck units from G, c, and h.

Penrose, R. (1965). Phys. Rev. Lett., 14, 57; Hawking, S. W., & Penrose, R. (1970). Proc. R. Soc. A, 314, 529. The singularity theorems: classical physics drives itself to breakdown at t=0. Penrose's 2020 Nobel Prize.

Electroweak Unification (Lab-Confirmed Physics, Unobserved Epoch)

Glashow, S. L. (1961). Nucl. Phys., 22, 579; Weinberg, S. (1967). Phys. Rev. Lett., 19, 1264; Salam, A. (1968). Nobel Symposium No. 8. Electromagnetism and the weak force merge above ~100 GeV. Nobel 1979.

ATLAS Collaboration (2012). Phys. Lett. B, 716, 1; CMS Collaboration (2012). Phys. Lett. B, 716, 30. Higgs boson discovery, the mechanism giving particles mass. Nobel 2013.

Baryogenesis (Before 1 Microsecond)

Sakharov, A. D. (1967). JETP Letters, 5, 24. The three conditions for the matter-antimatter imbalance.

Planck Collaboration (2020). Astron. Astrophys., 641, A6. Precision measurement of the ~6 x 10^-10 baryon-to-photon ratio, the leftover matter.

Quark-Gluon Plasma / Collider Recreation (~1 Microsecond)

Adams, J., et al. (STAR Collaboration) (2005). Nucl. Phys. A, 757, 102. RHIC evidence that quark-gluon plasma exists and behaves as a near-perfect liquid.

Aamodt, K., et al. (ALICE Collaboration) (2010). Phys. Rev. Lett., 105, 252302. LHC lead-lead collisions recreating the quark-gluon plasma at higher energies.

Big Bang Nucleosynthesis (3 to 20 Minutes)

Fields, Molaro & Sarkar. "Big-Bang Nucleosynthesis," Particle Data Group Review (2025 update). Light-element concordance, the 75/25 hydrogen-helium ratio.

Cooke, Pettini & Steidel (2018). ApJ, 855, 102. Precision primordial deuterium confirming nucleosynthesis predictions.

Cosmic Microwave Background (380,000 Years)

Penzias & Wilson (1965). ApJ, 142, 419. The discovery.

Mather, J. C., et al. (1990). ApJ, 354, L37. COBE blackbody spectrum verification.

First Galaxies (~300 Million Years)

Carniani, S., et al. (2024). Nature, 633, 318-322. Spectroscopic confirmation of a galaxy under 300 million years after the Big Bang (JWST).

Reionization Complete (~1 Billion Years)

Becker, R. H., et al. (2001). AJ, 122, 2850. Gunn-Peterson trough in a $z = 6.28$ quasar.

Solar System Formation (4.567 Billion Years Ago)

Connelly, J. N., et al. (2012). Science, 338, 651-655. Pb-Pb dating of the oldest solar system solids.

Earliest Confirmed Life (~3.5 Billion Years Ago)

Noffke, N., et al. (2013). Astrobiology, 13, 1103. Microbial structures in the ~3.48 Gyr Dresser Formation, Pilbara, Australia.

Nutman, A. P., et al. (2016). Nature, 537, 535. The contested 3.7 Gyr claim; disputed by Allwood, A. C., et al. (2018). Nature, 563, 241.