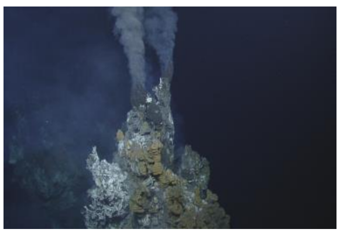
# Misconceptions about Evolution

## Lecture 5 Summer Session July 1, 2020

**EVOLUTION DOES NOT EXPLAIN THE ORIGINS OF LIFE ..**

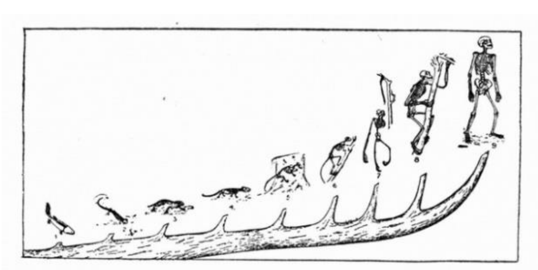
- Some people dislike evolution because they don't understand how it explains how life began. But there's a reason for that: **Evolution doesn't explain how life began**, nor was it **ever intended to**. ..(6:24)( (Location timer on the computer- in parentheses )
- Evolution explains **how existing life changes over time**. (6:36) But it doesn't explain the beginning—which is an entirely different thing. The term for that is **abiogenesis, which means life from nonliving matter. .(6:44)**
- Science doesn't actually understand in detail the process whereby life began. That doesn't mean that scientists are utterly clueless on the topic; it's just that they don't know the entire story. ..

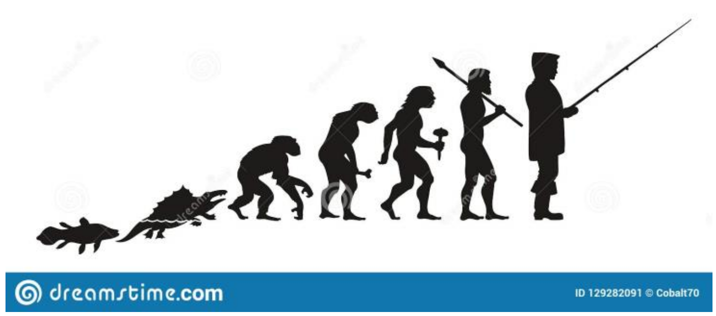


- We think that **life likely formed in a chemically volatile environment** with many highly active elements like sulfur. One very likely candidate location is deep-sea vents— places at the bottom of the ocean where magma is very close to the surface. This magma heats the water, which mixes with the elements normally found only deep in the interior of the Earth. ..
- The simple fact is that **evolution is the change of life over time**, but before evolution can begin, life or some sort of **protolife has to already have existed**. This is simply a misunderstanding of the definition of the term evolution.

**HUMANS DID NOT EVOLVE FROM CHIMPS..(8:07)**

The claim that **humans evolved from chimpanzees is a very common misunderstanding** about evolution. It's said dismissively by some who think the claim flies in the face of their understanding of the uniqueness of humans, but perhaps the reason this idea persists is just the simple way in which evolution is taught.



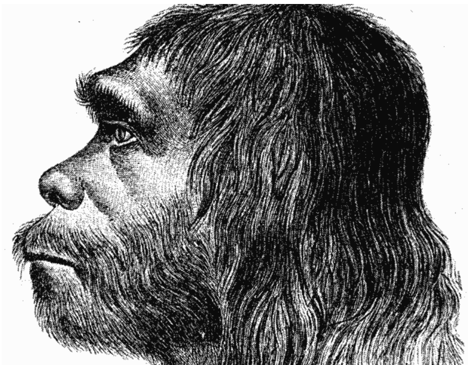



- We are taught **a linear model of evolution**, with fish turning into lizards, turning into animals, and then monkeys, and finally humans. ..(8:45)
- A related question that arises when people consider **the idea that humans arose from**

**chimps is why there are still chimps if we came from chimps**.

- These 2 ideas stem from an incorrect genealogy mindset. **It starts with you and then asks where you come from.** From a patrilineal standpoint, you came from your dad, who came from your grandfather, who came in turn from your great-grandfather, and he came from your great-great-grandfather—etc. ..
- It stands to reason that if you came from your great-great-great-great-great-grandfather, then he shouldn't be around now. After all, he's been dead for hundreds of years. ..
- So, if you evolved from a chimpanzee, then why are there still chimpanzees? ..
- That's actually not the right way to think about genealogy. **That paternal line is a real thing**, but it's much more complicated. (9:46) After all, **your dad might have had several siblings** who might have had children of their own. These would be **your cousins**. And the same thing is true of your grandfather. The grandchildren of your grandfather's siblings would be your second cousins, and so on.
- And, of course, **this has entirely ignored the women involved**. There were also mothers and grandmothers and aunts who are related to you. When you try to do a family tree, it becomes quite complicated, with all kinds of connections. ..(10:20)
- **Evolution is also like this**. There is a direct line of ancestors linking you to the first creature that ever lived, but there are also cousins and uncles and aunts and other relatives. Organisms that recently split from the line linking humans to the first living thing are, in evolutionary terms, cousins. **In the case of human evolution, the cousins would be a now-extinct form of humans called Neanderthal**. .. (10:32)
- **This does not mean that we descended from Neanderthal**. In fact, that particular species lived at the same time as our own ancestors. **They were first cousins**, from an evolutionary standpoint. **They even occasionally interbred with the ancestors of humanity.** So, in a way, Neanderthal are partially part of our ancestry. It just turns out to be not much. ..(10:57)
- Getting back to humans and chimpanzees, **it turns out that chimpanzees are actually a distant cousin of humans. We share an ancestor.**

**Most modern humans have** only about **1% to 4% of their DNA from Neanderthal**, although this is true only of people whose recent lineages didn't originate from Africa. If you are **Nigerian, for example, you probably don't have any Neanderthal DNA in you**. **Neanderthals didn't evolve in Africa**, nor did they coexist with the more recent ancestors of Africans. (11:31)



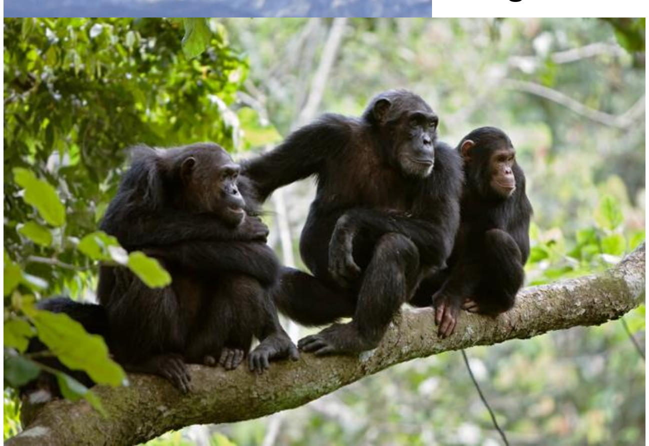

From a body shape point of view, **the ancestor of humans and chimpanzees looked more like chimps than humans.** They **were short and muscular, with powerful arms and jaws.** They could **climb better than humans do**, with feet that could grab tree limbs. Then, over the years and centuries and millennia, **the 2 groups became more and more distinct**, with **some of those ancestral populations evolving into chimps and the others evolving into humans. ..**

- The **split between chimpanzees and humans started perhaps 10 million years ago**. It would be simple if the split began with 2 different brothers, one of whom evolved into humans while the other evolved into chimps, but that's not how it really went. ..
- Instead, **the process took millions of years, with 2 populations of the ancestors of humans and chimps that became increasingly isolated from each other**. However, during those millions of years, there was some continued breeding back and forth. It was **only about maybe 6 million years ago that the separation became more or less permanent.**
- ..**Modern humans had additional ancestors, such as Australopithecus and Homo habilis,** and, just as there was some interbreeding between our recent ancestors and Neanderthal, **there was some interbreeding between our ancestral line and some of these more distant cousins.** (13:09)

**EVOLUTION DOES NOT HAVE A GOAL** (13:32)

..The **misconception that evolution has a goal is a very common one**. It somehow imagines that **there is a purpose for every evolutionary trait**.

- For example**, in insects, birds, and mammals, each group has developed species that can fly**. It doesn't stretch the imagination much to think that it's somehow inevitable that flying will one day be evolved by other species. **The word inevitable presupposes that there is some sort of goal or endpoint of evolution**. And that's just not how any of this works. (14:04)



- **There is evidence that Humans are intelligent**. And there are other species that have degrees of intelligence. **Apes and monkeys can solve complex problems to get food, as can octopi, ravens, and dolphins**. While none of these species have the same level of intelligence as humans, **this suggests that intelligence is a feature that species would evolve toward.** (14:39)**..**
- **Suppose that some terrible new disease evolves that completely wipes out the entire human race. How long will it take for humanlike intelligence to evolve again?** (15:43)**..**

That's a reasonable question to ask, but it entirely begs the question. Is it so obvious **that intelligence will evolve ever again? ..**

**It may surprise you that the answer is actually no.** To the best of our knowledge and over the course of the history **of our planet, humanlike intelligence evolved only once**. And if humans died out tomorrow, **there is no guarantee that intelligence would ever evolve again.** (1627:)

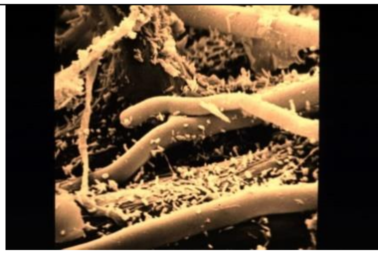
- **Evolution is really about making sure that a species has enough successful offspring that at least some of them make it to adulthood and then reproduce themselves.** And that cycle has to happen repeatedly for thousands of generations. (16:48)..
- **To be evolutionarily successful**, you need to be **able to gather food** reliably, whether that means to be **able to eat many forms of plant life or be an effective and efficient hunter**. You need to **be able to avoid being eaten**, or to ensure that a close genetic relative avoids getting eaten. **You need to make enough babies to ensure** that at least some of them have babies. .. (17:13)
- There are many different **ways to ensure reproductive success**. Having **more offspring** is usually a good thing, as it helps you beat the odds. And there are other and more immediate ways to survive, such as being faster or stronger or armored. .. (17:52)
- In other words, there are many ways to survive; **there's no single right way**.
- The bottom line is that **evolution doesn't have a goal**. It's just the process of small changes in the capabilities of organisms being pitted against the environment and some of those changes helping the organisms survive. If those organisms survive, they have babies, and organisms without those changes have fewer babies. Over time, the organisms' great-great-great-grandchild could look very different. And that's evolution(21:48)

**EVOLUTION DOES NOT MEAN THAT MORE-COMPLEX ORGANISMS WILL FORM ..**

- The **misconception that evolution means that more-complex organisms will form** is very similar to the previous misconception. ..

- **There is an idea that we humans are the very pinnacle of evolution** and that we somehow are more complicated and intricate than all other creatures. **But this viewpoint is extremely arrogant and wrong.**

By about 3.5 billion years ago, there is pretty unambiguous evidence of life. Prior to that, the evidence is sketchier, but there are **some scientists who claim to have found evidence of life maybe as early as 4.2 billion years ago**— shortly after the Earth formed. .. (23:53)

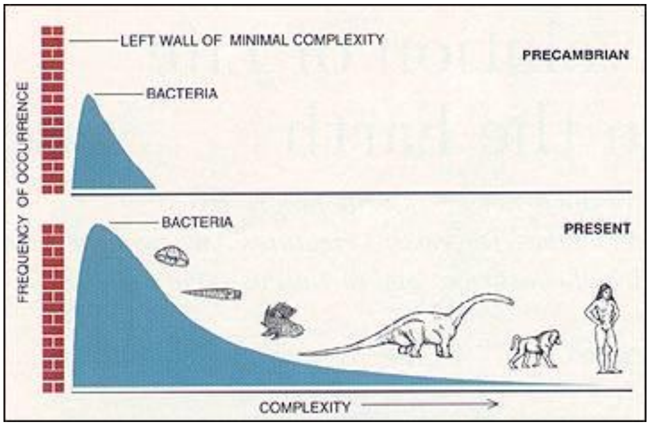


It's not that we humans are fundamentally better than other organisms**; we're just different**, and **we're certainly not more evolved.** ..

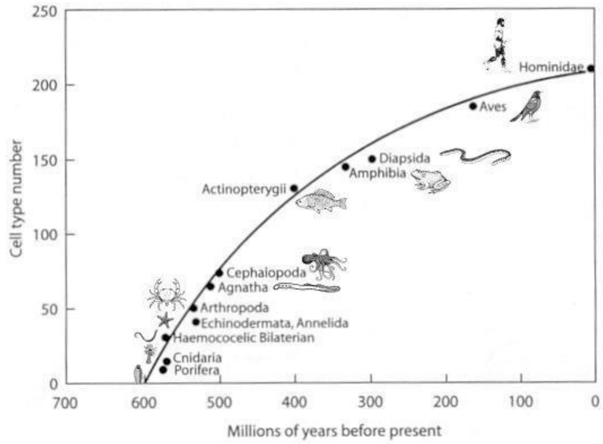
The mindset arises in the usual way—with images that have fish becoming lizards, becoming mammals, becoming primates, and finally becoming humans. It's very easy to fall into the **intellectual trap that creatures are getting better**. But that's not how evolution works.

Remember that **evolution is about reproductive fitness and the ability to survive**. .. **cockroaches and atomic Bombs.**

**This plot** has on the **horizontal axis the complexity of organisms** and on the **vertical axis how much of life on Earth is of that amount of complexity.** There is a minimum complexity of life, with a big bump at low complexity and a long tail for more complexity.




(25:46)



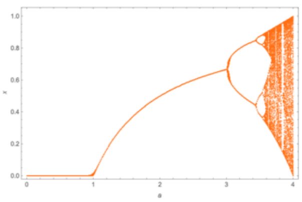

This was explored by a Physicist named Michael Feigenbuam, at the Los Alamos National Laboratory in New Mexico to study turbulence in fluids. He Discovered a relationship that could be used in the study of population dynamics…

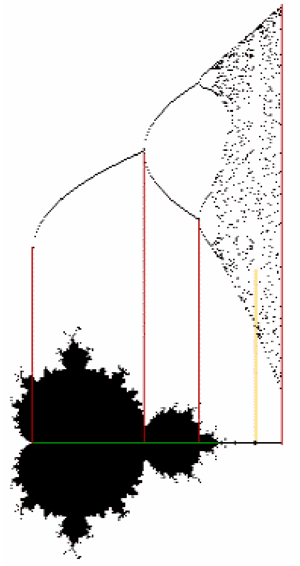
The Chaos Formula → $X_{n+1}=\lambda(1-X_n)$ 4.669 - The Feigenbuam Constant-

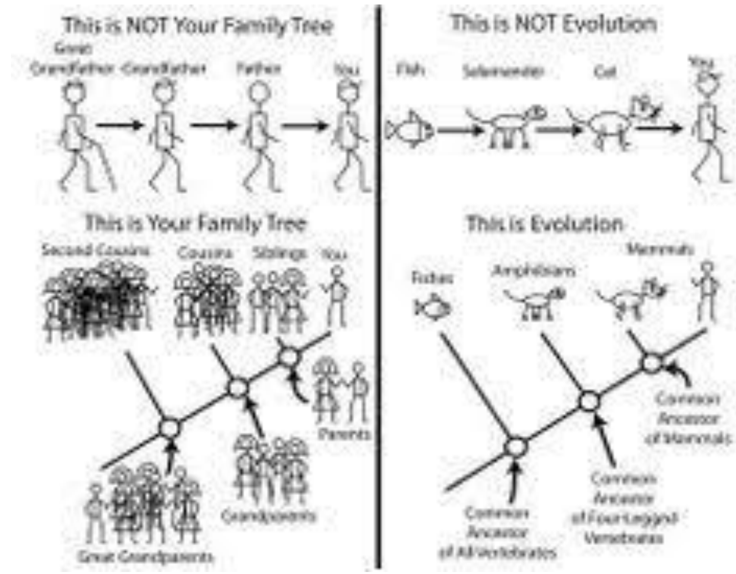
$X_{n+1}$= Next years Population count

λ = fertility ability

$1-X_{n}$(= Previous population count








If evolution favors more-complex creatures, **you'd expect to see the bump move to the right, with complex creatures becoming common**. But that's not what we see. Instead, you see that **the bump doesn't move much** and just **the tail grows a little longer**. ..
The message here is **that more than 500 million years ago, the dominant form of life was the single-celled organism**. Fast-forward to the present and you still see that the dominant form of life on the planet is also not very complex. . (27:11).
In fact, **evolution doesn't lead to complexity—it leads to variety. ..**

**Over the last 500 million years, bacteria have had time to evolve prodigiously**. (1. remarkably or impressively great in extent, size, or degree)
There are countless species of single-celled organisms, including bacteria, that have evolved to live in every imaginable environment, from the hot cauldron of thermal vents at the bottom of the ocean to highly acidic lakes. These organisms can be found in places that would kill any more-complex creature, yet they thrive. This is due to billions of years of evolution. **Bacteria have more species than humans by 10 million to 1**. They also **have a mass of about 1000 times more than humans.** (29:30)

Humans are by no means the most evolutionarily successful species on the planet. **We live in a world dominated by single-celled organisms. ..**

And **while these organisms are less complex than multicellular life**, **they've been evolving over the last few billion years since our last common ancestor lived.** This pushes home the message that evolution doesn't lead to complexity. The score that we're judged against is the longevity of the species, and humans have a long way to go before we can be considered a successful one. (29:59) The End (30:32)

# Addendum:

# A Surprising Possible Genetic Reason why Females may Outlive Males

There may be a surprising reason why women outlive men that's genetically related.

The reason women outlive men may not be as so commonly thought: things such as high stress jobs, physically demanding jobs, men primarily fight wars, or even smoking being higher in men than women all these causes but maybe not the main overall reason.

New theories may put the blame on the sex chromosomes themselves.

In animals in general the male chromosomes having the X and Y chromosomes may put them at a specific disadvantage. In humans, females are the homogametic sex, with 2 of the same type of sex chromosomes. XX In males they are the hetero-gametic sex having X and Y chromosome.

A recent study looked at life span data for 229 species of different animals, that have chromosomal sex determination like humans. It was discovered that the homogametic sex individuals lives on average up to 17.6 % longer than the hetero-gametic sex animals.

So why in the opinion of the researchers: redundancy due to the XX chromosomes.
This extra life was thought to be because of the double X redundancy. There are many genes on the X chromosome, many have nothing to do with Sex characteristic . An example of this …The Gene that allows us to see color is on the X chromosome. If female receives a harmful gene on the X chromosome than the other X chromosome could Have a healthy copy of the genetic message the harmful gene and send the healthy message.

Males by having only one X chromosome, therefore one chance..there is no backup for faulty genes. Again females may have a backup healthy gene expression to send a healthy message, whereas males do not have that backup ability.

Males are more likely to express harmful x chromosomes traits…an example red – green colorblindness traits. Or more serious maladies like Fragile X syndrome,(An inherited condition characterized by an X chromosome that is abnormally susceptible to damage, especially by folic acid deficiency. Affected individuals tend to have limited intellectual functions.) and Dushane Muscular Dystrophy,( a severe form of muscular dystrophy caused by a genetic defect and usually affecting boys.)

This trend hold up regardless of differences between sexes.

Birds have an inverted Chromosome system from mammels For them females are the hetergametic organisms and males are the homogametic animals and Males outlive females, on average regardless of behavior. Redundancy may be an important factor in longevity.

**Citations:**

Inherited Colour Vision Deficiency – Colour Blind Awareness. (2019). Colour Blind Awareness. **http://www.colourblindawareness.org/colour-blindness/inherited-colour-vision-deficiency/**

Why do men — and other male animals — tend to die younger? It's all in the Y chromosome. (2020). EurekAlert! **https://www.eurekalert.org/pub_releases/2020-03/uons-wdm030320.php**

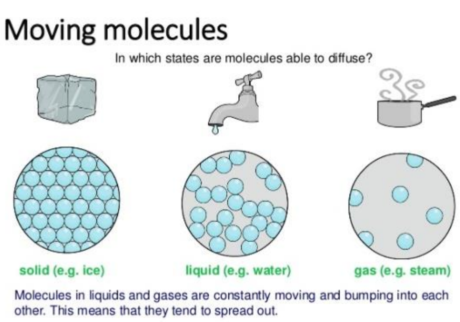
Xirocostas, Z. A., Everingham, S. E., & Moles, A. T. (2020). The sex with the reduced sex chromosome dies earlier: a comparison across the tree of life. Biology Letters, 16(3), 20190867. **https://doi.org/10.1098/rsbl.2019.0867**

## Presentation 6 Summer Session July 1, 2020
## Does Thermodynamics Disprove Evolution?
HEAT RISES .. (1:00)

The misconception that heat rises is said so often that it's not even questioned by people. There is a kernel of truth to this; it's just **oversimplified** to the extreme. (1:20)
In everyday language, heat is what warms you up. In physics, heat is a form of energy. Even more technically, heat is a kind of energy that can be transferred from a hot object to a colder one. (2:04) Tying the technical and vernacular together, a hot thing is something that can transfer heat energy. .. (2:32)

Suppose you filled 2 identical pans with an identical amount of tap water. If you put one of the pans to the side and the other on your stove and heated it up to bathwater temperature, how would the 2 pans now be different? ..Obviously, one is cold and one is warm. But how did that happen? .. (3:21)
Using the stove, you added energy—in the form of heat—to one of the pans, and that energy is now stored in the water. You can think of the water as essentially being an energy sponge. . (3:35).

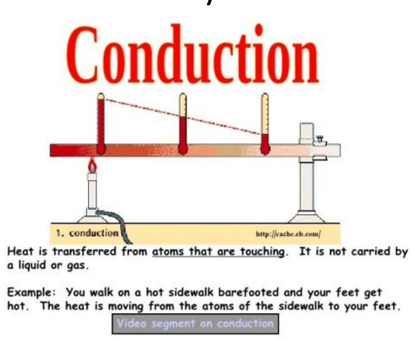
To understand where that energy really goes, you can think of the pan of water as holding a bunch of tiny water ($H_2O$) molecules, which are basically like microscopic marbles. .. (3:57)




When you add energy to water, the marbles start moving more quickly. They zoom around faster, but they also rotate. And in the case of these water molecules, they can also vibrate. At an atomic level, this is what's really going on when you heat up a pan of water. . (4:30).

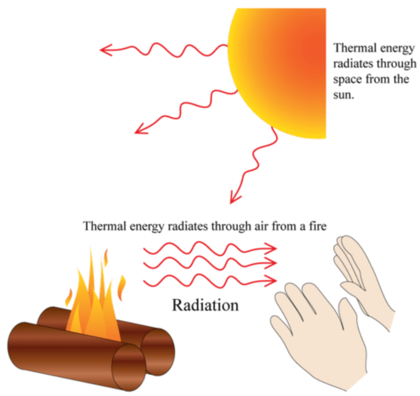
When people say that heat rises, they mean that one place gets warmed up and one place cools down. Taken literally, the phrase heat rises presumably means that the place above a warm object will warm up while the object itself would cool down. This is all about how heat energy is transferred. (5:06)

There are 3 ways to transfer heat.

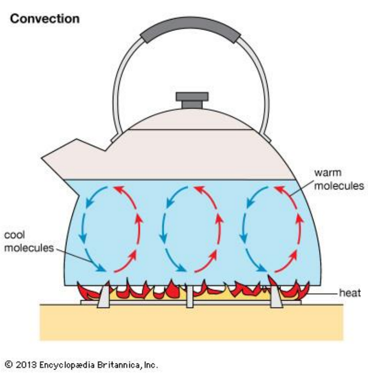



1. Conduction involves directly touching the hot object. An example would be putting your hand in warm water.
The vibrations of the molecules of hot water would vibrate the molecules of your hand, thereby speeding them up. And if

molecules moving, bending, and shaking is what heat energy is, this means that your hand would heat up. You could put your hand anywhere in the water and your hand would heat up. And in a pan, the water at the bottom might be hotter. This shows that heat conduction doesn't participate in heat rising. In conduction, the only direction that matters is the interface between vibrating and non-vibrating molecules. (6:00)

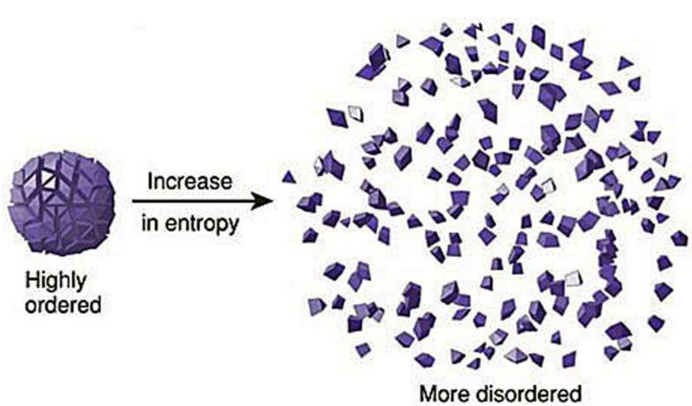



2. <u>Radiation</u> is when an object is heated enough that it gives off electromagnetic radiation. If you start a fire, you see the glowing light. That's visible light. However, you can't see all kinds of electromagnetic radiation; some are invisible to the eye. One type is infrared radiation, which will cause objects to start moving, which means that it will heat things up. And you know around a campfire that you don't have to be above the fire to feel heat coming to you. You can sit beside it and warm your hands or feet. Obviously, that's heat energy moving to the side, not up. So, the transfer of heat energy due to radiation doesn't respect the "heat rises" rule. (7:02)




3. <u>Convection</u>—which does experience the "heat rises" rule—occurs when you take a heat source and put it in a movable medium, such as air or water. If you put air, for example, near a hot object, the moving molecules of the hot object will pass heat energy to the air via conduction. But if that movable medium starts to absorb heat energy and its molecules start to move around, they will take up more space. That's because the molecules move and bounce into other molecules and push them away. This effect ripples across the medium (in this case, the air), and the result is that the air becomes less dense. Then, the air rises through the medium—the remaining air. So, in the case of convection, it's OK to colloquially say that heat rises. The reason why air-filled objects like pool toys float on water is because they're less dense. (8:39)
(Ya da ya da)
ENTROPY AND EVOLUTION ..(9:56)

The second law of thermodynamics says that the **entropy of the universe can never decrease**.



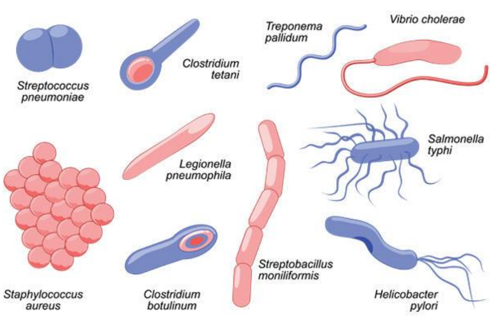

Often, the word entropy is considered to be roughly synonymous with the word disorder. But that's not true. .. (12:58)

Note that the fact that the **entropy of the universe can never decrease** is **not the same** as saying that **entropy always increases**. .. (12:31)

This **flawed idea of entropy as increasing disorder** can be combined with a common understanding of evolution that is also incorrect. .. (13:58)

**Evolution** is often thought of as **a continuous increase in complexity**. Roughly, the idea is that evolution goes from less-complex forms of life to more-complex ones.  Basically, the simple understanding is that bacteria became fish, which became amphibians, and then lizards, then mammals, and then humans. It started with simple and ended up with complex. . (14:07).

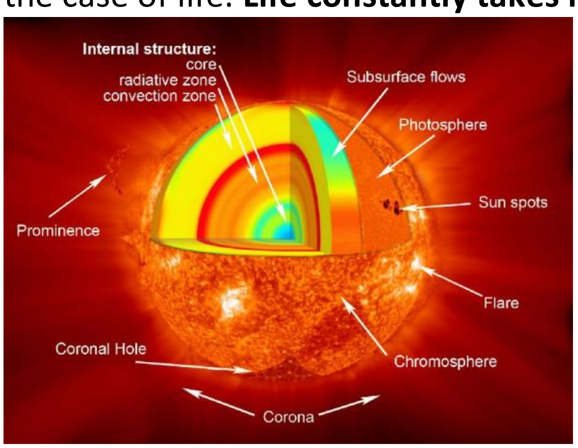

If you take these 2 ideas—that the **laws of thermodynamics require that things fall apart** over time **and that evolution makes things more refined and complicated over time**—you can see where people might get the idea that the 2 statements are in contradiction. (14:27)..




But **evolution doesn't imply an increase in complexity**. In fact, as discussed in the chapter on evolution **the most common form of life on the planet has always been single-celled organisms. ..** (14:47)

There is another problem with how people commonly understand the law of thermodynamics. The correct statement of **the second law of thermodynamics is that the total entropy of an isolated system can never decrease over time**. .. (15:14)

Isolated, **in this context, means that no energy flows in or out**. And that clearly isn't true in the case of life. **Life constantly takes in energy**. (15:35)




Taken at a much larger level, there's this giant ball of fire in the sky that keeps our planet from being a frozen, ice-covered rock. .. (15:52)

The Earth is not an isolated environment. And because of that simple fact, the claim that the second law of thermodynamics disproves evolution is simply wrong. . (16:13).

Every year, the Earth absorbs more energy than can be extracted from all of the fossil fuels and easily accessible uranium.

However, there is another and subtler reason why the laws of thermodynamics are being mangled when they are used in this way. It's because people are misusing the idea of entropy. (16:26) Entropy really isn't disorder in the sense that most people understand it. It's more correct to say that **entropy is a measure of the number of ways something can exist and still look more or less the same. ..** (16:41)

To try to make that more understandable, consider 10 fair coins that can be heads or tails and lay them out next to one another. . (16:51).

There is only a single way that all of the coins can be heads, and there is only a single way that all of the coins can be tails. This is also true of the scenario where the coins are heads, tails, heads, tails, and the pattern repeats itself for all of the coins. Because there is only one way these coins can be in each configuration, these are all equally likely, and **they all have a low entropy**. (17:11).

How many ways can these coins have 1 heads and 9 tails? The first coin can be heads, the second coin can be heads, the third one can be heads, etc. This means that there are 10 distinct configurations that satisfy the requirement that there be 1 heads. This means that the entropy is higher for the configuration with exactly 1 coin being heads. (17:37)

**Combinatorics-** the branch of mathematics dealing with combinations of objects belonging to a finite set in accordance with certain constraints, such as those of graph theory.

You can also figure out the number of different ways in which you can get 2 heads from the 10 coins. You can do it the hard way, by counting them and adding them all up, or you can use a **mathematical theory called combinatorics**. .. (17:59)

It turns out that while there is only **one way to get 0 heads** and **10 ways to get 1 heads**, there are **45 ways to get 2 heads**, **120 ways to get 3 heads**, **210 ways to get 4 heads**, and **252 ways to get 5 heads**. After that, the number of configurations goes down. After all, there is only one way to get 10 heads. (18:12)

| Percentage Heads | Percentage Occurring | Percentage Heads | Percentage occurring |
|---|---|---|---|
| 0 | 0 | 6 | 210 |
| 1 | 10 | 7 | 120 |
| 2 | 45 | 8 | 45 |
| 3 | 120 | 9 | 10 |
| 4 | 210 | 10 | 1 |
| 5 | 252 | | |

The exact mathematics isn't important; **what is important is the trend of the numbers**. There are simply more ways—more configurations of coins—to get 3 heads than there are to get no heads. And the most likely configuration is to get 5 heads. There are 252 more ways to do that than there are to get none.     (18:39)
**And this means that the entropy of getting 5 heads is higher than getting none**. There are simply more ways to do it. .. (18:45)

242 ways to make change for a dollar. (Reference is A Snapple Lid)
Using quarters, dimes, nickels and pennies there are **242 ways** to make change for a dollar. It's **293** if you also use half-dollars****I Just thought this was interesting.

**This is what is meant by entropy in the second law of thermodynamics**. A closed system—one that energy flows neither into nor out of—tends to move to configurations that are superficially similar but just have more ways to be like that. (19:01:)

For more information on thermodynamics, check out the Great Course Thermodynamics: Four Laws That Move the Universe.

Some people say that entropy is a measure of disorder, but it's not. Entropy is a measure of the number of ways things can look like each other at the big-picture level but be different at the detailed level. .. (20:22)This misunderstanding of the meaning of the word is another reason why people who try to use the second law of thermodynamics to invalidate evolution are so far off. Aside from misconceptions about the nature of evolution, they've completely neglected **the fact that the Earth and ecosphere isn't a closed system, and they've used an analogy for the word entropy rather than the precise mathematical formulation.** (20:49)

HEAT AND TEMPERATURE (21:09)

There are many misconceptions of how heating things works that are less subtle than the ones revolving around entropy. . (21:20).
The idea that putting a pan of water over a fire will constantly heat it up with a smoothly changing temperature might sound reasonable to you. But the fact is that it's not true—or at least not completely true. .. (21:43)

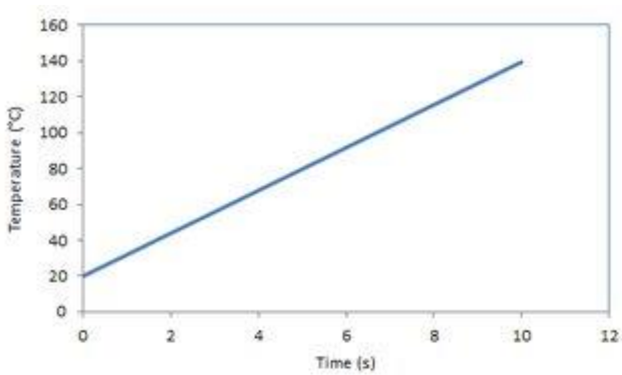
Suppose you put 1 kilogram, or 2.2 pounds, of ice into a very strong and sealed metal container and started heating the container. To monitor what is going on, you put a thermometer into the ice before you froze it. .. (22:02)

To make the experiment easy to interpret, you put the same amount of energy into the container every minute. In other words, you put the container over a nicely constant flame. (22:16)

Imagine that you took the ice out of a typical home freezer, which is set at −20° centigrade, or just shy of 0° Fahrenheit. Then, you heated it up to 120° centigrade, or about 250° Fahrenheit. (22:35)

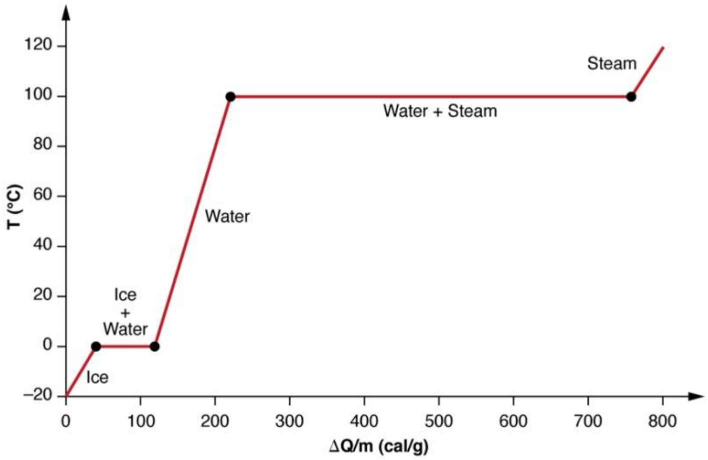
Most people would think that the temperature of the ice—then water, then steam—would change constantly as the energy was constantly added. .. (22:43)

The following graph shows what most people commonly would think. On the bottom of the graph is the amount of energy added. .. (22:48:)




It turns out that it takes just shy of 2900 units of energy to heat ice from −20° centigrade to 120° centigrade, so that part is right. But focus on the shape. The graph is just a straight line—a constant change in temperature as energy is added. .. (23:13)

But that’s not what happens when you actually do the experiment. Instead, if you slowly and constantly added about 2900 units of energy, you’d see the temperature rise, then stay constant at 0° centigrade, then rise again, then stay constant at 100° centigrade, and then rise again. .. (23:24:)




Those numbers—0° and 100° centigrade, or 32° and 212° Fahrenheit— are the freezing and boiling temperatures of water. (23:37)

| Initial temp | Final Temp | Energy requir | Cumulative E | Process |
|---|---|---|---|---|
| -20 | 0 | 42 | 42 | Warm ice |
| 0 | 0 | 334 | 376 | Melt ice |
| 0 | 100 | 420 | 796 | Warm water |

(24:07)

The big picture is that it doesn't take much energy to change the temperature of ice or steam. It takes about twice as much energy to change the temperature of water 1° compared to ice and steam.

| Initial temp | Final Temp | Energy required | Cumulative Energy | Process |
|---|---|---|---|---|
| -20 | 0 | 42 | 42 | Warm ice |
| 0 | 0 | 334 | 376 | Melt ice |
| 0 | 100 | 420 | 796 | Warm water |
| 100 | 100 | 2030 | 2826 | Turn water to Steam |

(24:30)

| Initial temp | Final Temp | Energy required | Cumulative Energy | Process |
|---|---|---|---|---|
| -20 | 0 | 42 | 42 | Warm ice |
| 0 | 0 | 334 | 376 | Melt ice |
| 0 | 100 | 420 | 796 | Warm water |
| 100 | 100 | 2030 | 2826 | Turn water to Steam |
| 100 | 120 | 40 | 2866 | Heat Steam |

(24:51)

It’s very difficult to change the temperature of water. If you took a certain amount of energy that would increase the temperature of a kilogram of water by 1° centigrade, that same energy would raise the temperature of a metal by 8° centigrade. It’s twice as hard to heat up water as it is to heat up alcohol. It’s 5 times easier to heat up asphalt than it is to heat up water. This is partly why your driveway gets so hot compared to your swimming pool.

**The big energy hogs are the melting and boiling stages**—and especially the boiling one. It’s the phase transitions, or changes in state, that really eat up energy. (25:20)

| Specific Heats of Selected Materials | |
|---|---|
| **Material** | **C (J/kg·K)** |
| Aluminum | 897 |
| Concrete | 850 |
| Diamond | 509 |
| Glass | 840 |
| Helium | 5193 |
| Water | 4181 |

( 26:25)

Water is basically an enormous heat sponge. It can soak up a huge amount of energy without changing its temperature very much. And the opposite is true. That’s because when water does change its temperature, it does so by absorbing a lot of energy. It is much harder to cool off.

Boil water in a paper cup Video …..

Alpha source - Smoke detector –
Alpha source - Coleman lantern Mantles-
Beta- source TV picture tube..
Any electron source….Make a Alumin foil hat to block Beta radiation.
Gamma – cosmic rays saturate a cloth with methanol place is a clean mayonnaise Jar on bottom of jar shine a bright flash light…If the interior is saturated with alcohol vapor as Cosmic rays pass thru you will see the tracking’s of the rays or their alpha particle.
Gamma cont. High Energy Photons.
remnants from cosmic rays interactions with Earth’s atmosphere.