Black Slide

One of the most compelling questions facing mankind, is… “How did we get here?”

“This is a universe that knew we were coming.”

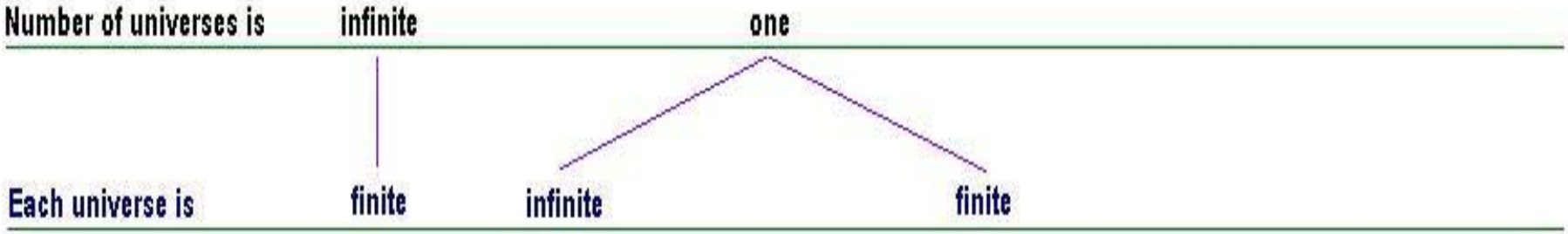
Freeman Dyson. 1979. Disturbing the Universe (New York), p.250

Most of the scientific community now generally agrees: the universe is fine-tuned for life.

Currently, there are about eight attempts to explain this fine-tuning. (Lee Smolin, 1997, The Life of the Cosmos, and Paul Davies, 2008, The Goldilocks Enigma.) Most of them can be grouped into three possibilities, all of which involve the concept of infinity, because only infinity can provide sufficient conditions for such a situation to occur.

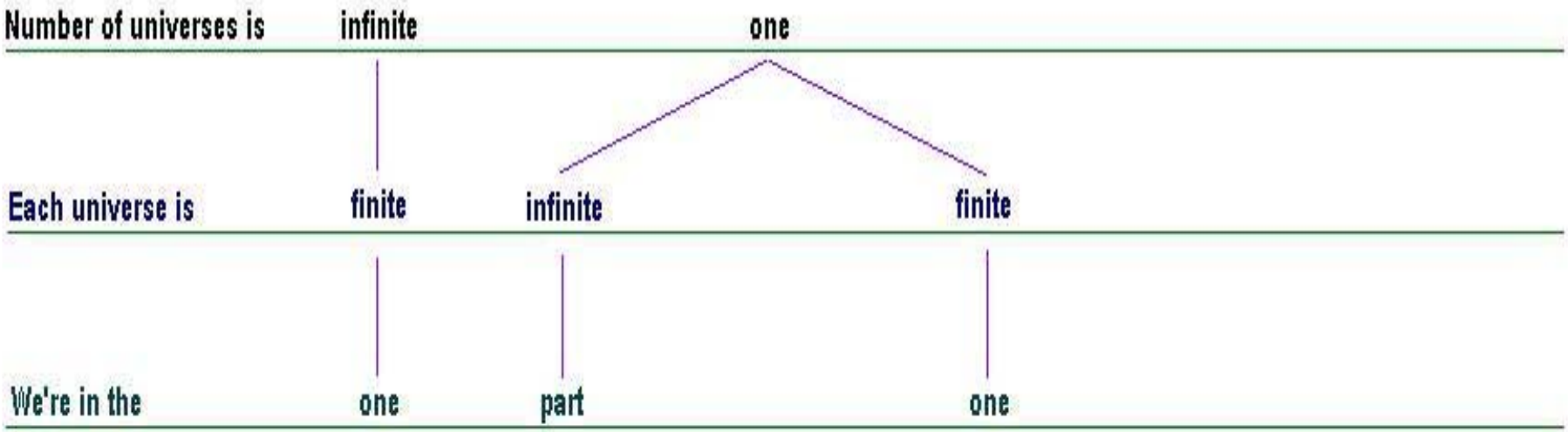
Number of universes is	infinite	one

These explanations start with two possibilities:
There are an infinity of universes or there is one.

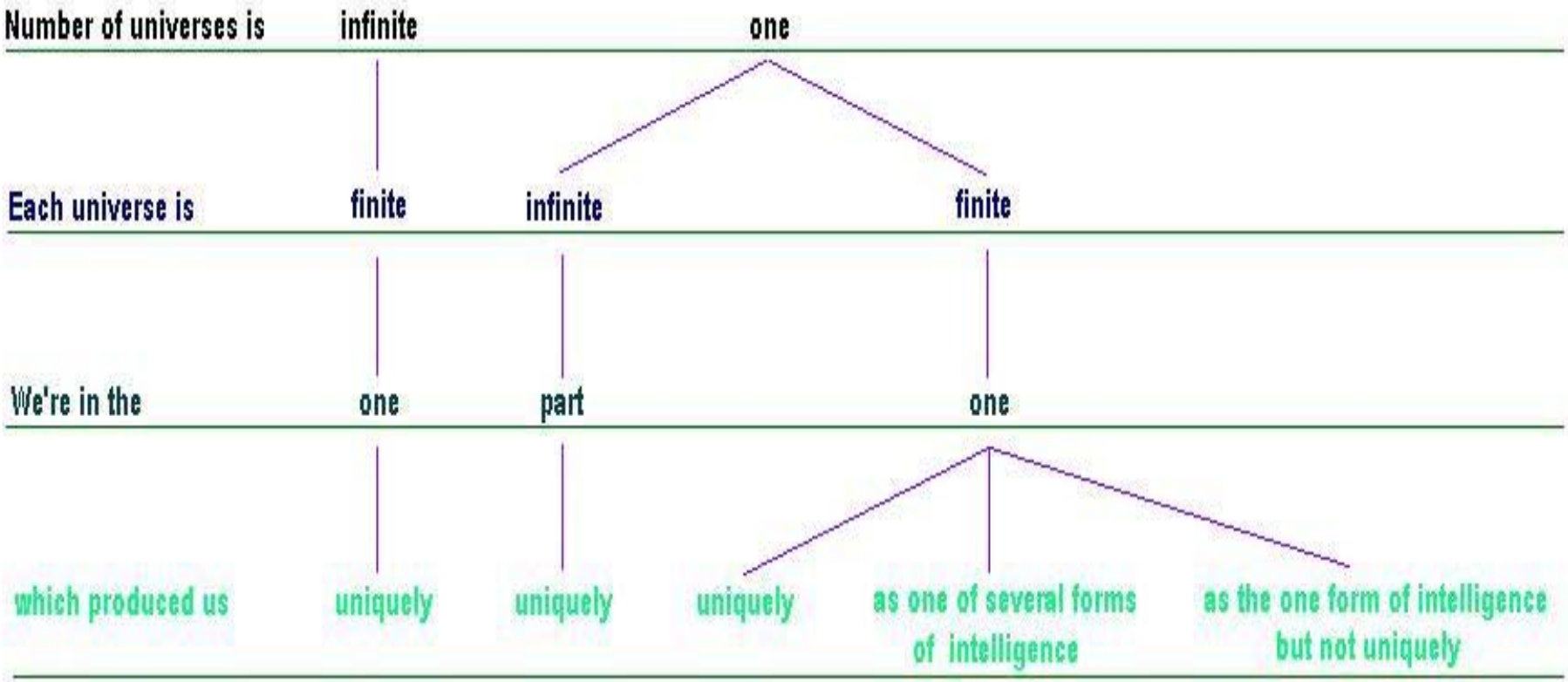

Number of universes is
infinite
one
Each universe is
finite
infinite
finite

These two possibilities lead to three further possibilities:

Each universe in the infinity of universes is finite;
the one universe is infinite, or
the one universe is finite.

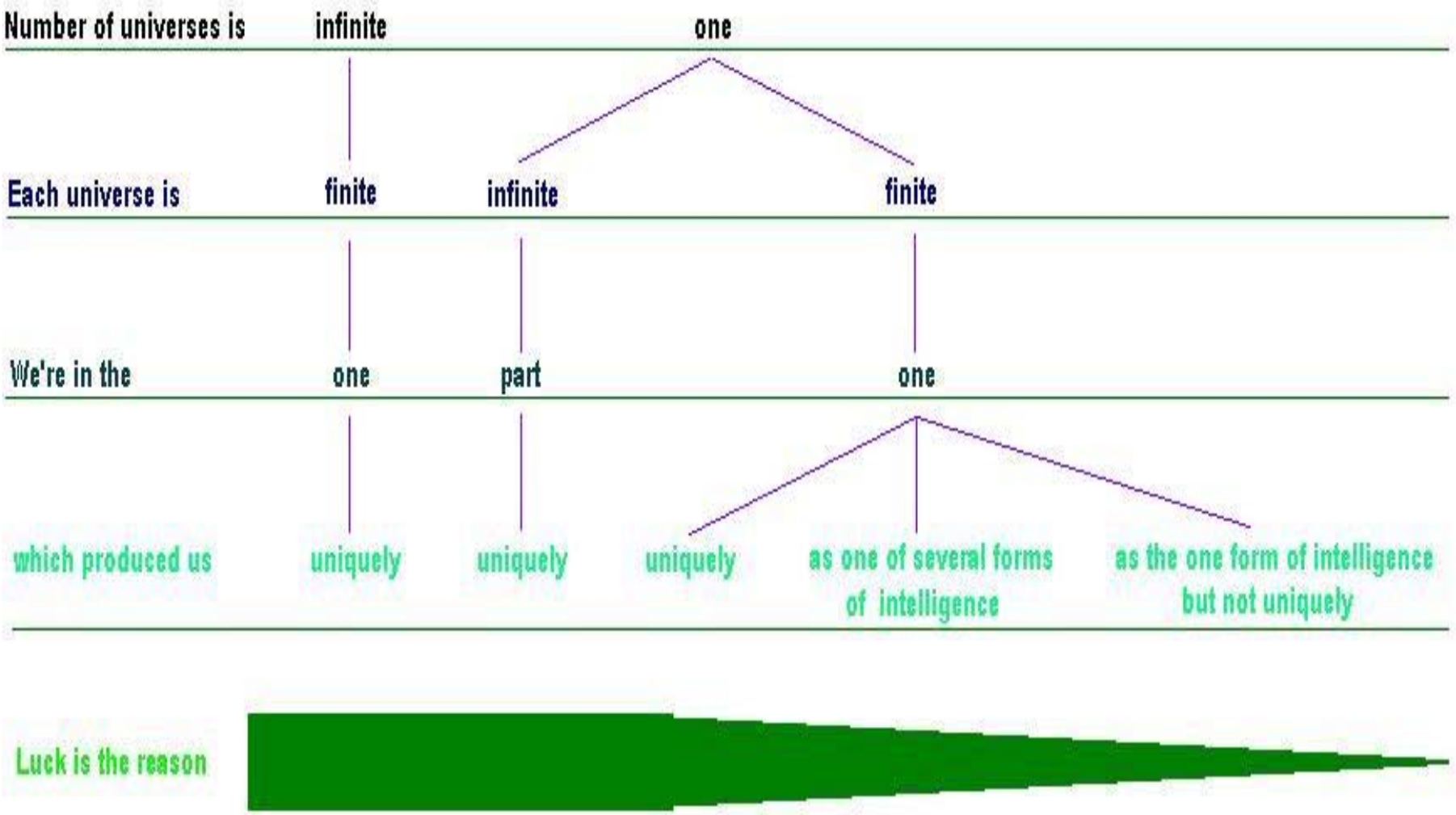

Number of universes is
infinite
one
Each universe is
finite
infinite
finite
We're in the
one
part
one

In each case, we are in the one, the part, or obviously, the one, which . . .


Number of universes is
infinite
one
Each universe is
finite
infinite
finite
We're in the
one
part
one
which produced us
uniquely
uniquely
uniquely
as one of several forms of intelligence
as the one form of intelligence but not uniquely

produced us, uniquely or,
in the latter cases,
could also have produced us as one of several forms of intelligence or
we are the one form of intelligence but we have evolved elsewhere in the universe.

Why would these latter two cases even be likely considering the fact that so far we are the only ones we know of? Before we answer that, let's step back and look at where we are relative to the original question-how did we get here?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We're in the
one
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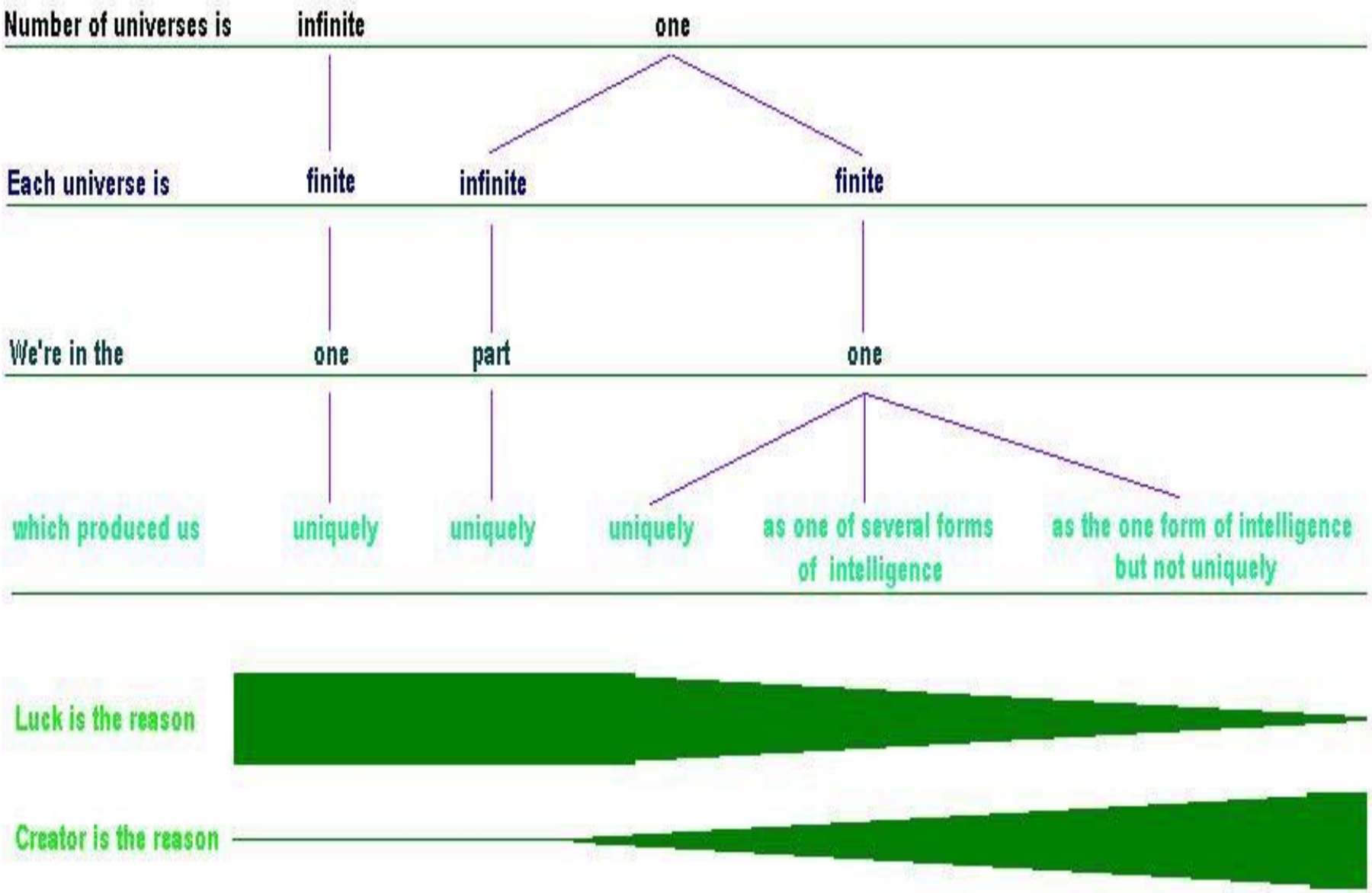
which produced us
uniquely
uniquely
uniquely
as one of several forms of intelligence
as the one form of intelligence but not uniquely
Luck is the reason

If we look at the conditions that produced us
as we proceed from left to right,
the argument that luck is the reason becomes
less compelling.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one
Each universe is
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finite
We're in the
one
part
one
which produced us
uniquely
uniquely
uniquely
as one of several forms of intelligence
as the one form of intelligence but not uniquely
Luck is the reason
Creator is the reason

This is where the third infinity comes in:
We are created by an infinitely wise creator, who fine-tuned the universe to produce life, intelligence and perhaps specifically, human kind as the end product of His creation.

While the argument that we were created becomes more compelling. Notice that in neither the explanation calling on luck or the one calling on a Creator, does the other completely disappear.

Now, back to the other issue, why would we even consider the two rightmost possibilities? . . .

Nine Phenomena That Recur Throughout Cosmological, Abiological, and Biological Evolution

(that just might produce something like us elsewhere in the universe)

Carlos F. A. Pinkham
Norwich University, Northfield, VT

ASA/CSCA Annual Meeting
4 August 2008

Title page

Approach

The Algorithm

The Phenomena

Attributes with Examples

Conclusion

I will break the presentation into these four parts.

The Algorithm

The accuracy and precision found in numerous fundamental constants, forces, and masses established at the moment of the Big Bang

↓

Nine phenomena that allow the universe to support the evolution of intelligent life via the survival of the fittest.

↓

Attributes which imply that the universe was designed, that we will explore with examples from:

↓

Cosmological Evolution → Abiogenesis → Biological Evolution

The algorithm can be expressed as a thesis in which fundamental constants, forces, and masses established at the Big Bang produce nine phenomena that work to support the process of evolution at the cosmological, abiogenesis, and biological levels such that we or something very similar to ourselves will emerge. This thesis will be illustrated with specific examples.

The accuracy and precision found in numerous fundamental constants, forces, and masses

Cosmological Constant

Weak Nuclear Force

Strong Nuclear Force

Electromagnetic Force

Gravity

Mass of proton

Mass of electron

Mass of neutron

The algorithm starts with the fundamental constants, forces, and masses listed here, and others that were established at the instant of the Big Bang. It is now clear that these had to be precisely tuned for life to emerge and as most of you know, this concept is referred to as the "anthropic principle," in its broadest, extended sense. I will discuss the CC shortly.

The four forces govern reactions between matter in the universe and the three masses are the dominant players in this matter.

The Phenomena Verbalized

1) Many “requisite singularities" exist for the evolution of “human” life.

2) Conditions in the universe operate such that the requisite singularity is associated with “precise peaks.”

3) Each requisite singularity is an “optimal solution” to design considerations.

3) “Compelling attractors” around the precise peaks cause the precise peaks to be found.

4) Furthermore, conditions in the universe ensure that each requisite singularity will occur in an “ample sample.”

6) Thus with an ample sample and adequate elapsed time, the requisite singularity will be found with “statistical certainty.”

7) Once found, each requisite singularity results in “narrowing options” for future evolution, thus giving rise to

8) an “essential sequencing" of requisite singularities. Finally, the above often results in

9) an “intricate simplicity" of requisite singularities.

The phenomena are consequences of the necessary accuracy and precision required of these numerous fundamental constants, forces, and masses for a universe (this universe in particular) to support the evolution of not only life, but intelligent life and maybe even humanoid life. The phenomena are . . .

(I will give you a moment to read them-then I will try to make sense of them for you).

The Phenomena Formulated, 1

REQUISITE SINGULARITY:

B must occur if life is to arise or evolve.

PRECISE PEAK:

Conditions that result in B often operate with great precision to ensure that precisely B will occur.

OPTIMAL SOLUTION:

B works best at meeting specific requirements; not B', B'', b', b'‘, or 1.

COMPELLING ATTRACTORS:

Conditions naturally result in B, and while they may also make B^- and B^+, these either do not work as well as B or do not work at all.

AMPLE SAMPLE:

Conditions that result in B are such that B will occur in abundance (and often, so will B^-, B^+ , b', b'‘, and/or 1).

It is important to clarify these nine phenomena. To do this as succinctly as possible, letters, numbers and symbols will be used. They should be understood to be general representations of actual conditions that have relationships to one another somewhat in the same ways letters of our alphabet or numbers in a series are related to one another. We all understand “A” comes before “B”, there is a difference between “B” and “b’”, but these two are also more alike than “B” and “1” are alike, and so on:

The Phenomena Formulated, 2

STATISTICAL CERTAINTY:

Because of all the above, B, not B^-, B^+, B', B'', b', b'' or 1 will be found by cosmic, abiological, or biological evolution, to fulfill the requisite singularity.

NARROWING OPTIONS:

Furthermore, once found, B → C, not 1, nor □, because neither 1 nor □ are now possible or effective.

ESSENTIAL SEQUENCING:

This leads to requisite singularities occurring in order: A → B → C → D etc, & B cannot occur before A occurs.

INTRICATE SIMPLICITY:

Although the above may result in 10,11,12,13,14,15…99, different steps or different categories of requisite singularities, this intricate variety of differences can be simply summarized as tens, twenties, thirties, etc.

It must be acknowledged that the phenomenon of intricate simplicity may be a result of mankind's desire to simplify and categorize, but one can speculate why that desire is an aspect of intelligence….

The Attributes with Examples

The Big Bang and the Cosmological Constant

Carbon

Water

Cell Metabolism

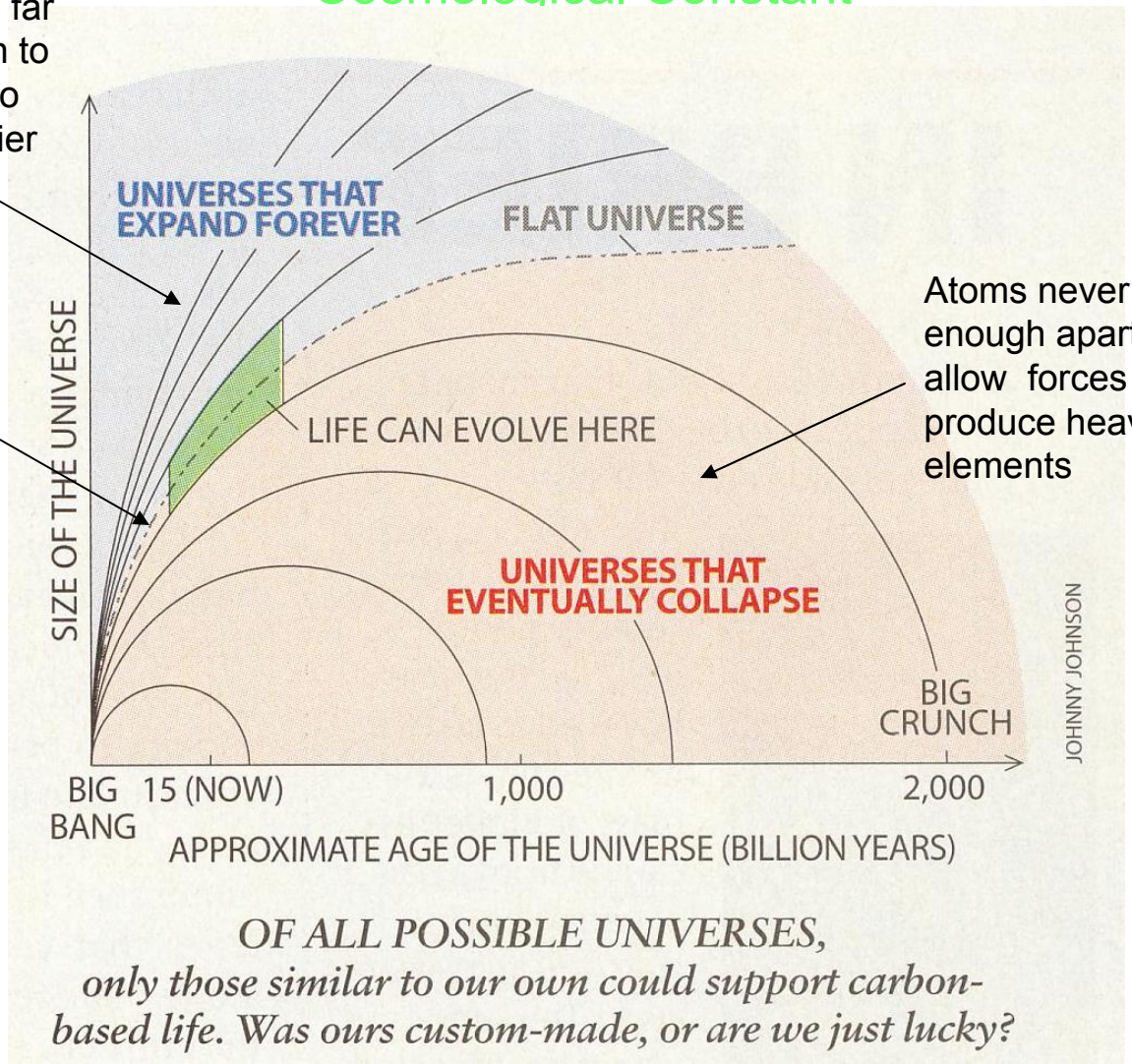
Senses and the Brain

I will briefly give examples of the thesis as it applies to the creation of the universe (the Big Bang) then as it applies to four levels of complexity: the atom, the molecule, the cell and the organism. There are others that could have been presented and others yet to be identified.

The Big Bang and the Cosmological Constant

Atoms get too far apart too soon to allow forces to produce heavier elements

Not ready, yet



Atoms never get far enough apart to allow forces to produce heavier elements

Gibbs, W. Wayt. 1998. Beyond physics: renowned scientists contemplate the evidence for God. *Scientific American*. 279(2):20-22.

13.7 billion years ago, the universe began with a Big Bang. It began as an incredibly hot, incredibly dense collection of very high-energy photons. At the instant it began, it possessed a number of unique constants, forces, and future mass values that had a profound effect on subsequent cosmological and biological evolution. From the initial moment of the universe until now, not only has this intense mass expanded and cooled because of the tremendous energy imparted to it, but space itself has expanded and at one point, very shortly after it began, for a brief instant, it inflated.

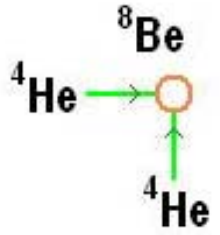
One of the critical constants is the "cosmological constant." It is what lies behind the rate of expansion of the universe. Without going into the details, one aspect of this is that if it were larger by 1 unit at the 50th decimal place, the universe would have expanded too fast and there would be little in it besides scattered hydrogen, helium and a few lithium atoms. If it were smaller by 1 unit at the 50th decimal place, the universe would not expand fast enough to escape the force of gravity and it would fall back on itself in a "Big Crunch."

Requisite Singularity	Attribute	Precise Peak	Optimal Solution	Compelling Attractors	Ample Sample
A universe with the right mix of elements and age to allow intelligence to evolve	Cosmological Constant (CC) (the quantum level of complexity)	CC must be accurate to the 50th decimal point	As far as we can determine… Obviously	Conditions on either side of CC that cause the universe to fail to produce us	NA, (unless you subscribe to the Multiverse)

Attribute	Statistical Certainty	Narrowing Options	Essential Sequencing	Intricate Simplicity
Cosmological Constant (the quantum level of complexity)	We do have a universe.	Once it and the other Cs, Fs, Ms are established, outcome is predictable	Can't have us until we have a universe with the CC	The Big Bang is incredibly complex, yet easy to grasp.

Thus, the CC is one of the attributes that meet the *requisite singularity* for a universe that has just the right mix of elements and is around long enough for these elements to evolve into intelligent life, and in particular, us. The CC must act at a *precise peak* and the conditions around this peak do serve as *compelling attractors*.

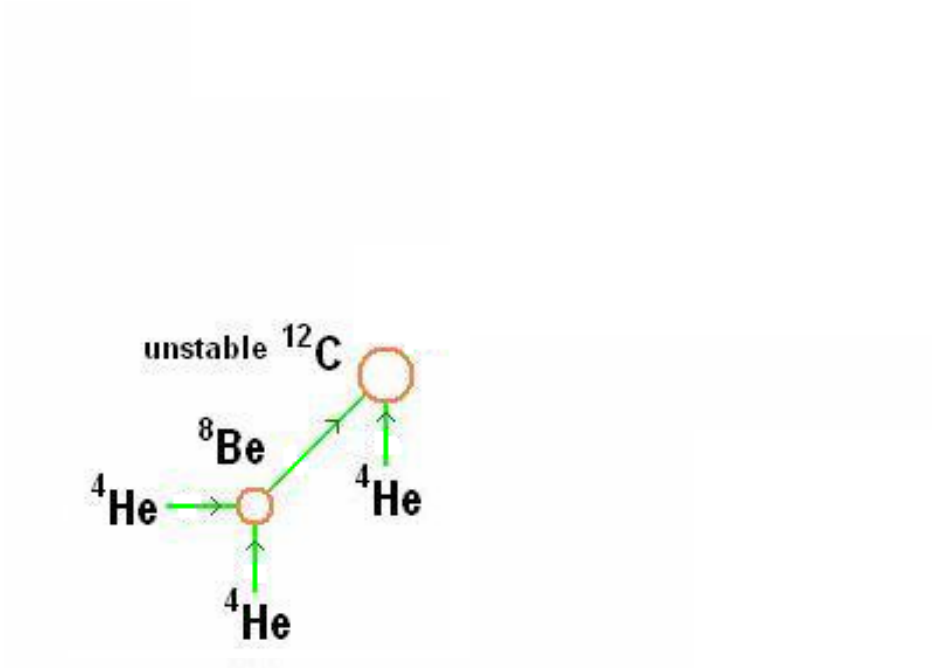
Carbon



At the level of the atom, Carbon provides a good example of the phenomena.

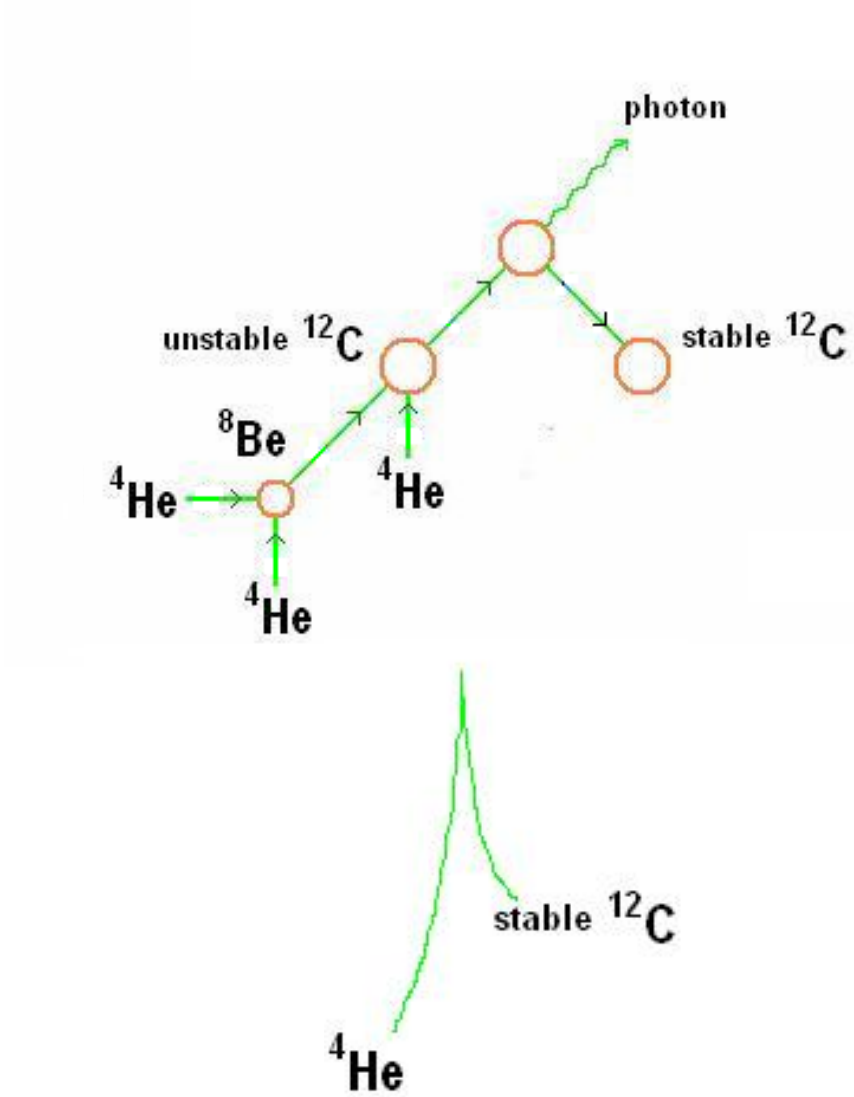
Carbon forms the backbone of the myriad of chemical compounds essential to life. The activation energies for the formation of carbon by fusion in first generation stars is a sharply peaked function: Two ^{4}He collide to form a ^{8}Be, which has a very short half life.

Carbon



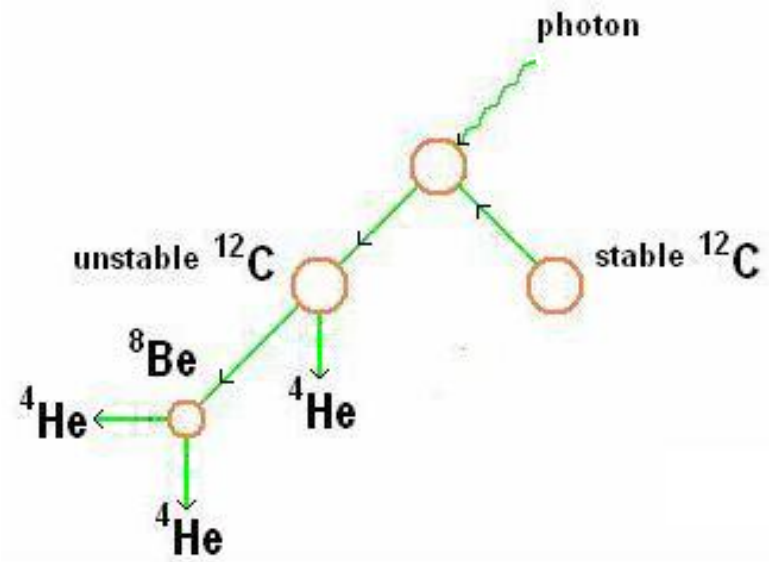
If another He impacts it before it decays back to two ^{4}He's, an unstable form of C will form.

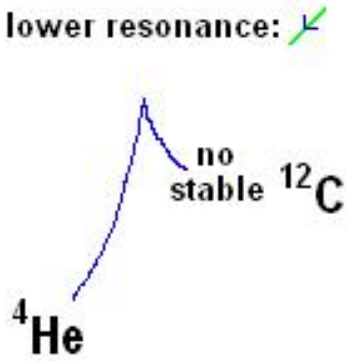
Carbon


photon
unstable ^{12}C
stable ^{12}C
^{8}Be
^{4}He
^{4}He
^{4}He
stable ^{12}C
^{4}He

This unstable carbon will give off a photon, loose sufficient energy, and fall into a stable carbon state.

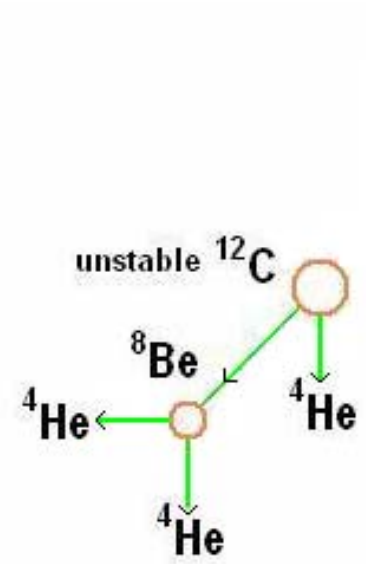
Carbon


photon
unstable ^{12}C
stable ^{12}C
^{8}Be
^{4}He
^{4}He
^{4}He


lower resonance:
no stable ^{12}C
^{4}He

If the resonance of this reaction were any lower, the reaction could reverse from the “stable” carbon and the universe would be without carbon or be without much carbon.

Carbon


unstable ^{12}C
^{8}Be
^{4}He
^{4}He
^{4}He


higher resonance:
no
stable ^{12}C
^{4}He

If the resonance of this reaction were any higher, the unstable carbon would not form, or if it did, it would quickly decay back into ^{4}He and ^{8}Be before it could give off the photon and the universe would be without carbon.

Requisite Singularity	Attribute	Precise Peak	Optimal Solution	Compelling Attractors	Ample Sample
An element capable of making the myriad of compounds essential for life processes	Carbon (the atom level of complexity)	Resonance of C formation very precise	C forms 4 covalent bonds thus allowing for catanation w max possibilities	Conditions on either side of the resonance for C formation that fail to form C	C is 6th most abundant element in U, 14th on crust of Earth

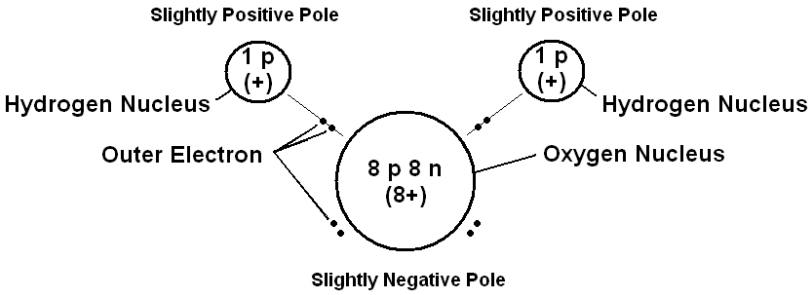
Attribute	Statistical Certainty	Narrowing Options	Essential Sequencing	Intricate Simplicity
Carbon (the atom level of complexity)	We do have lots of C	Silicon-based life is not a possibility	Can't have myriad of compounds w/out first having C	10 million organic compounds formed from C

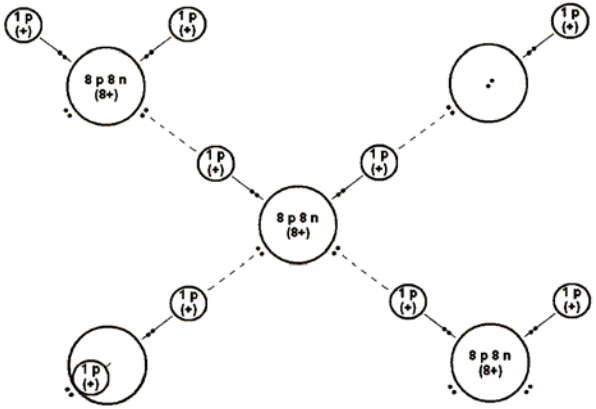
Carbon is the attribute which meets the *requisite singularity* for an element capable of making the myriad of compounds essential for life processes. If the resonance of these reactions were not at a *precise peak*, carbon would not form in sufficient abundance. It acts like an *optimal solution* because the resulting four electrons in the outer orbit provide the geometric maximum number of bonds while they are close enough to the nucleus that they form them with sufficient strength that they are covalent bonds which allow catanation, the major reason carbon can form so many compounds. If these resonances were either higher or lower, carbon would not form, thus its formation has c*ompelling attractors* around it.

Because of these properties, carbon has been produced in an *ample sample*. The other elements with a close atomic number or four orbital electrons (Si) are also produced in an *ample sample* by similar mechanisms or mechanisms dependent upon the life-history of stars. Once produced in sufficient abundance, C has unique properties that ensure it and not the other elements will exist as the structural backbone of the large number and variety of different compounds essential for life. Thus it will be favored for this role with *statistical certainty*. Further, complex C compounds cannot form until C is formed, thus revealing an *essential sequencing*.

Water

Water Has to Have a Number of Very Special Properties





The Polarity of Water

Water and the Hydrogen Bond

Water and Ionization

Water and Temperature

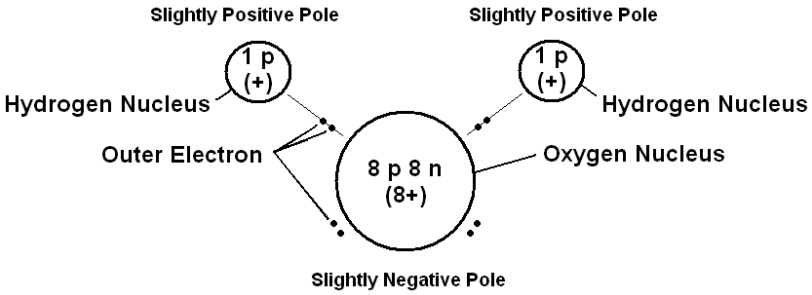
At the level of the molecule, water provides a good example of the phenomena.

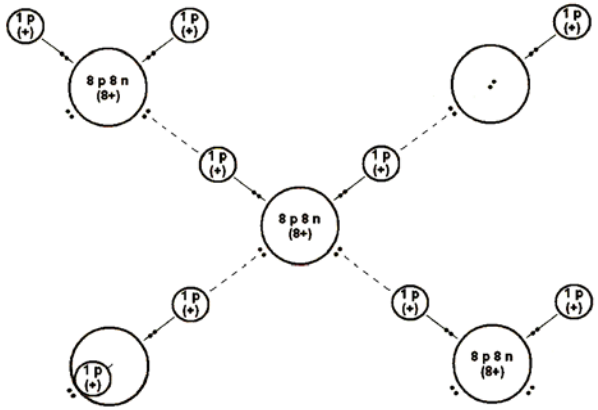
Because of the anthropic principle, water has a particular abundance and structure and this structure causes it to relate in a particular way with itself and other compounds such that it contains or forms the four major chemical bonds essential to life: covalent, electrovalent, hydrogen & Van Der Waal's forces. Thus, of all possible compounds, only one, water, has the 50 or so unique properties necessary for it to act as the single most important compound to life. These properties are the result of four interdependent aspects of the way water behaves

The Polarity of Water
Water and the Hydrogen Bond
Water and Ionization
Water and Temperature

Water

Water Has to Have a Number of Very Special Properties





- Possibly most abundant dielemental molecule in the universe
- Best solvent and transport agent for charged and polarized compounds
- The highest combined heat storage capacity (specific heat), heat loss at freezing (heat of fusion) and heat input at boiling (heat of vaporization) of all compounds
- High incompressibility
- High cohesive and adhesive forces
- Lighter as a solid than as a liquid

Without going into the details, the anthropic conditions and these resulting four properties ensure that water:

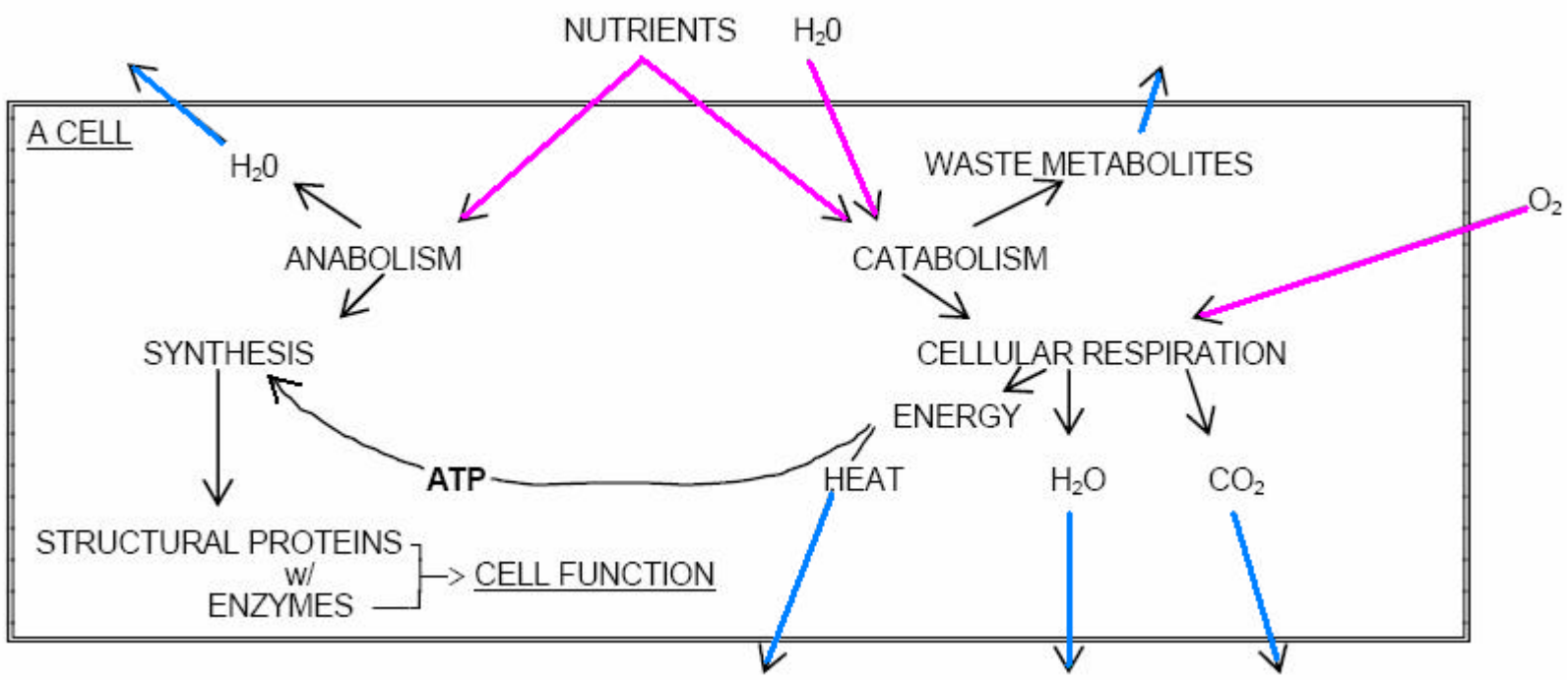
- is possibly the most abundant dielemental molecule in the universe.
- is a great solvent and transporting agent for charged particles and polarized compounds.
- has great heat storage capacity (specific heat) and gives off considerable energy when it freezes (heat of fusion) and requires considerable energy to make it boil (heat of vaporization) such that it works to stabilize ambient temperatures.
- is highly incompressible so that it will produce turgor pressure.
- has high cohesive forces so that it will have high surface tension and high adhesive forces so that it will provide capillary action.
- has a configuration in the liquid and solid states that makes ice float on water thus permitting life to exist in the water beneath the ice.

Requisite Singularity	Attribute	Precise Peak	Optimal Solution	Compelling Attractors	Ample Sample
A solvent for life processes that also acts as a heat reservoir & has other essential properties	Water (the molecule level of complexity)	Resonance of oxygen formation very precise, like that of C	Nothing works as well as water	Properties of H and O that make formation of water a given	Water is possibly single most abundant dielemental molecule in Universe

Attribute	Statistical Certainty	Narrowing Options	Essential Sequencing	Intricate Simplicity
Water (the molecule level of complexity)	H is most abundant element in U, O is 3rd and 1st on earth	Water determines the processes and forms that life will assume	Can't have transport & excitable tissues w/out it	That such a simple molecule could do so much

Water's unique properties enable it to fulfill an important *requisite singularity* at the molecular level. Since oxygen is formed in stars by the fusion of ^{8}He with ^{12}C, The resonance for the formation of oxygen must be precisely so, otherwise, its formation would use up all the carbon. The way its two atoms, hydrogen and oxygen, were formed and interact make it an *optimal solution* (pun noted but ignored). The other simple liquids have properties that make them unsuitable for this requisite singularity or have them at temperatures that are unsuited for life, thus they act as *compelling attractors* for water. H is by far the most abundant element in the universe since it was the first one to emerge from the Big Bang. It made up the bulk of the first stars referred to earlier. It is the tenth most abundant element in the earth's crust. Oxygen is the third most abundant element in the universe and the most abundant element in the earth's crust. Thus hydrogen and oxygen are guaranteed to occur in an *ample sample* and the formation of water must occur and once it does, it is clearly the only simple compound with this suite of characteristics. The form that life assumes must fit with these characteristics (*narrowing options*). Water, once it is formed, must be gathered together on a protoplanet before life can *evolve—essential sequencing* and its molecular weight makes sure it will remain in the atmosphere of an Earth-sized planet. Water's ability to illustrate all of the four common chemical bonds demonstrates *intricate simplicity*.

Cell Metabolism



At the level of the cell, the eukaryotic cell provides a good example of the phenomena.

Almost all eukaryotic cells have three fundamental inputs: nutrients, water, and oxygen (even plants follow this pathway at night); and four fundamental outputs: water, waste metabolites, carbon dioxide and heat. The process of cellular respiration captures approximately 18 times the energy as similar processes in prokaryotic cells.

The implications this figure has for the problems that must be solved by the multicellular chemoheterotrophs that would evolve from it are clear. Since most of the cells in a multicellular organism would be far removed from the surface where these elements and compounds were readily available (especially in the Precambrian oceans, where this process occurred), this development meant that ultimately, the complex organisms that evolved from this primitive chemotroph cell had to have: 1) a “digestive system” to get water and the nutrients into the body and break the latter down to small enough molecules to move them about. 2) A “respiratory system” to get the oxygen into the body (and simultaneously get the carbon dioxide out). 3) a “urinary system” to eliminate the excess water and metabolic wastes. And 4) a “circulatory system” to move the water, small nutrient molecules and oxygen from where they entered the body to where they were needed and to move the carbon dioxide, metabolic wastes and waste heat from where they were produced in the body to where they could be eliminated from the body.

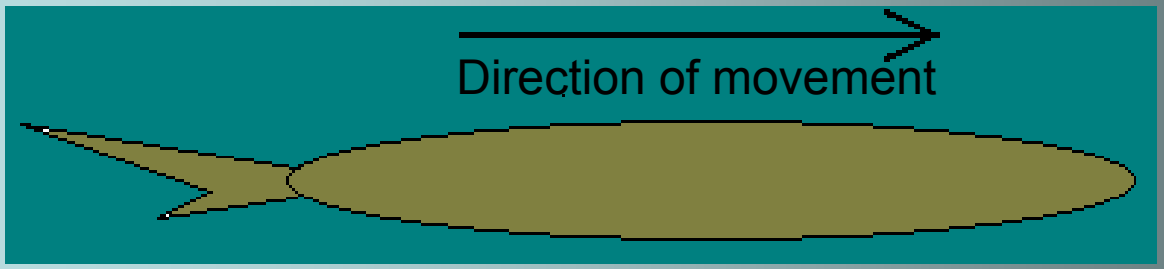
Finally, as the process increased in complexity with more advanced multicellular organisms, there would have to be a “nervous system” and an “endocrine system” to orchestrate all the above.

Requisite Singularity	Attribute	Precise Peak	Optimal Solution	Compelling Attractors	Ample Sample
Adequate energy production for the rigors of a larger cell size	Eukaryotic Cell Metabolism (the cell level of complexity)	Possibly 36 ATPs provides just the right energy budget	2 ATPs for prokaryotes, 36 for eukaryotes works fabulously	Endosymbiotic experiments that guarantee proper amount of energy will be produced	Untold numbers of primitive organisms with different metabolisms

Attribute	Statistical Certainty	Narrowing Options	Essential Sequencing	Intricate Simplicity
Eukaryotic Cell Metabolism (the cell level of complexity)	With the huge number of organisms eating each other, It was bound to happen	Once this plan in place, necessary organ systems for multicelled organisms established	Can't have multicelled organisms until have efficient production of ATP because of increased energy demand of multicell interactions	10,000s of chemical reactions in a cell, and this gets them all

Cellular repiration demonstrates a *requisite singularity* at the level of the cell. The evolution of this set of reactions was necessary to produce the amount of ATP needed for the higher energy demands of larger cells. The nature of the *precise peaks* here is less clear, perhaps some in the audience may have an idea. It certainly appears to be an *optimal solution* because it is found in almost all eukaryotic cells today in spite of other metabolic pathways being available through anaerobic and other metabolic schemes. This increased efficiency is explained by the endosymbiotic theory proposed by Lynn Marguilis and subsequently supported by several lines of evidence. It is proposed that other pathways, if they existed, would either be too wasteful or produce too little energy. If so, they would act as *compelling attractors*. In any event, the evolution of this heterochemotroph cell *narrowed the options* for the future evolution of complexity. Thus this step had to evolve before multicellular life with complex structures could evolve—*essential sequencing*. Finally this figure illustrates *intricate simplicity* by showing that the tens of thousands of metabolic steps in a cell can be summarized in a simplified diagram.

Senses and the Brain

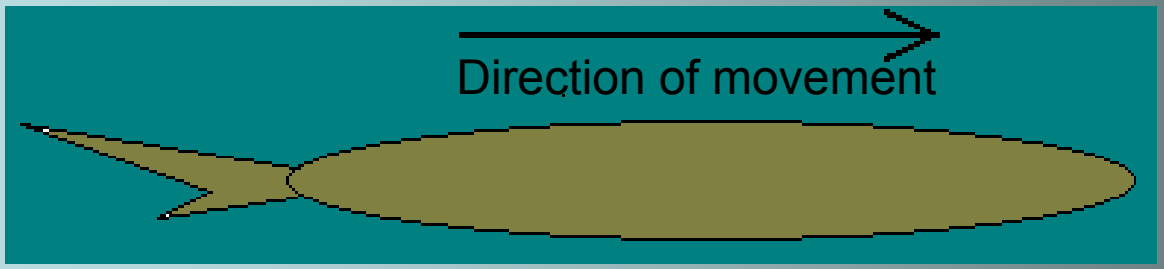


At the level of the organism, the relationship between the senses and the brain provides a good example of the phenomena.

We attribute special importance to the brain and therefore assume that its location is what drives much of our design, but let's look at this more closely.

Assuming an organism has a long axis, a preferred direction of movement will be established along this axis because of fluid dynamics (ultimately a result of the conditions in the anthropic principle). This will establish a "front" of the animal.

Senses and the Brain



Front

Low gradient of useful information High

As the animal moves through the environment, the most useful information to survival will be encountered at the front. It is more important to know what's ahead (coming up) than what's left behind.

Senses and the Brain

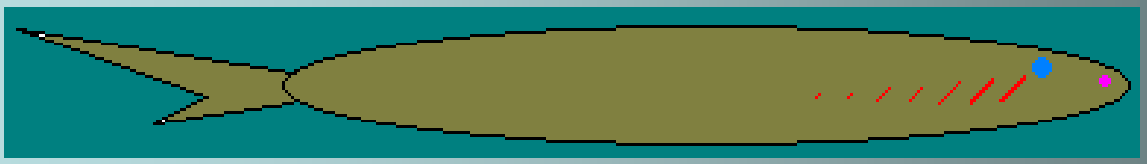
Front

Low gradient of useful information High

photons: **sight**

chemicals: **smell-taste**

pressure-forces: **vibrations-sound**



Information important to survival will be coming through three major sources:

photons, which will be intercepted by photoreceptors (sight)
chemicals, which will be intercepted by chemoreceptors (smell and taste), and
pressure-forces, which will be intercepted by mechanoreceptors (vibration and pressure)

The only other type of receptor is temperature (kinetic energy), which is intercepted by thermoreceptors, but these are less likely to follow this pattern, so they are not included here.

Because the most useful information to survival is coming from the front, natural selection will favor the solution that has these receptors occurring in the front of the organism.

Senses and the Brain

Front

Low

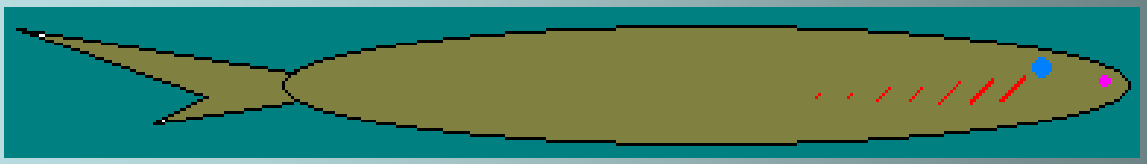
gradient of useful information

High

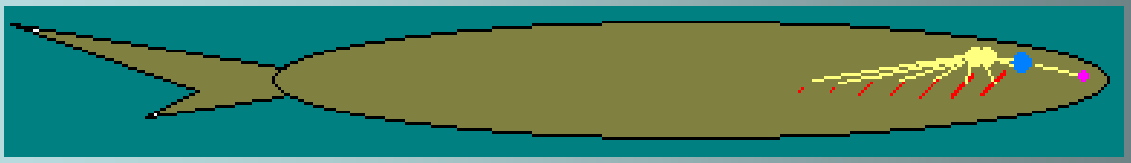
photons: **sight**

chemicals: **smell-taste**

pressure-forces: **vibrations-sound**



receiving-processing-responding center: **brain**



In order to ensure the center for receiving-processing-responding to the vital information coming from these receptors is able to do so as quickly as possible, it will be necessary for it to be as close to them as possible. Hence the brain is in the front of the body, not because it is of paramount importance (even though it is), but because it makes the most sense from design considerations for it to be there.

Requisite Singularity	Attribute	Precise Peak	Optimal Solution	Compelling Attractors	Ample Sample
An (anterior) organ that serves as an information receiver, processor & responder	Sentience & Intelligence (the organ system level of complexity)	Not sure here	Brain in front is best design solution	Fluid dynamics - information content of light, chemicals, & pressure	Lots of swimming critters

Attribute	Statistical Certainty	Narrowing Options	Essential Sequencing	Intricate Simplicity
Sentience & Intelligence (the organ system level of complexity)	Selection will favor this solution	Brain will be center for sentience (processing information)	Once established as the organ to process information, it is logical organ to evolve intelligence	Our brain with 100 billion cells with all its capabilities can be reduced to its role of processing information essential for survival

The evolution of the head with the special senses is a *requisite singularity.* Thus having the special senses at the front of the body, and the brain positioned close by is an *optimal solution*. Conditions established at the instant of the Big Bang set up the properties of water, etc., that ensured this singularity would be found. The brain, being the central processing center for environmental information, is the logical candidate to become the center in which further processing of information can be selected for and thus, the center for the further evolution of intelligence. It becomes necessary for *essential sequencing*. Furthermore, once this plan occurs, it becomes difficult if not impossible for evolution to break free from it to place the brain elsewhere, thus *narrowing the options* of future vertebrate plans.

Like any proper scientific thesis, this one has predictive powers:

•We will find the earlier stages more often and under a wider range of conditions.

•We will find later stages in proportion to the time since abiogenesis could have occurred in that star system.

•We will find the greatest departure from the evolutionary path taken on Earth as we get into more complex organisms, since the larger the organism, the fewer offspring it would have to provide an ample sample.

•We may well find the only other form of intelligence in the universe is humanoid.

•We may find that Ward and Brownlee's Rare Earth Hypothesis is not totally correct.

Although you think many of us here may not live to see this tested, before too long, we will have direct tests of this on Mars and even later on Jupiter's Galilean moons and Saturn's Titan. By 2020 or so, we will have space telescopes powerful enough to see extrasolar, Earth-like planets and spectroscopically examine the composition of their atmospheres.

Ward, Peter D. and Donald Brownlee. 2003. *Rare earth, why complex life is uncommon in the universe*.

In addition, this thesis will force us to closely consider the processes that brought us about and ultimately will provide a test of how well we understand them.

It also forces us to think, “What it is that makes us unique and how unique is that really apt to be?”

In any event, the more examples of requisite singularities that we find following this pattern, the more difficult it will become to argue that this is all by chance (Brandon Carter and Andrew Watson’s Critical Steps are considered “unlikely steps”).

Thus I make an appeal to all here to consider this thesis as it applies to their respective fields to see if additional requisite singularities are out there.

Carter, Brandon, 1983, *Philos. Trans. R. Soc. Lond*., A 310, 347-363.
Watson, Andrew, 2008, *Astrobiology*, 8(1): 175-185.

This view of creation does not require the Christian God. However, with proper spin on the words used, Genesis *does* follow the steps of the Big Bang and subsequent cosmological and biological evolution. But as always, there are alternate explanations (see Leslie's discussion of multiverses).

Even if the evidence for the existence of God in

- cosmological and biological evolution
- the Bible
- the life, death and resurrection of Jesus
- His fulfillment of so many Old Testament prophesies
- the conviction of the early witnesses
- the changed life of believers, and
- other witnesses we have all experienced,

taken as a whole, they are mutually supporting circumstances that cry out for understanding, for explanation.

They can be understood as being unrelated, with disparate explanations:

random chance, luck, mankind's need to explain the unknown, etc.

or they can be understood as being unified with a single, efficient explanation:

The God of the Bible.

Leslie, John, 1989, *Universes.*

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For more information, go to
http://www2,norwich.edu/pinkhamc/