Intelligence: Is it a physical quantity?

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The aim of this website is to logically analyze the origin of life from 'No life' era. The answer is probably hidden in the fundamental question – what is life? Or what is the source of the intelligence?

In the following article I have given a logical approach & tried to give some solution. Through it is hard to prove these hypothesizes experimentally, today but I hope that it will be possible one day. There is no philosophical or religious thought in my article. It is completely based on logic & mathematics. The readers of this blog are welcome to email me at dxtsantacena@yahoo.co.in. It will be my honor to receive any criticism or feedback from the readers.

INTELLIGENCE: IS IT A PHYSICAL QUANTITY?

Introduction

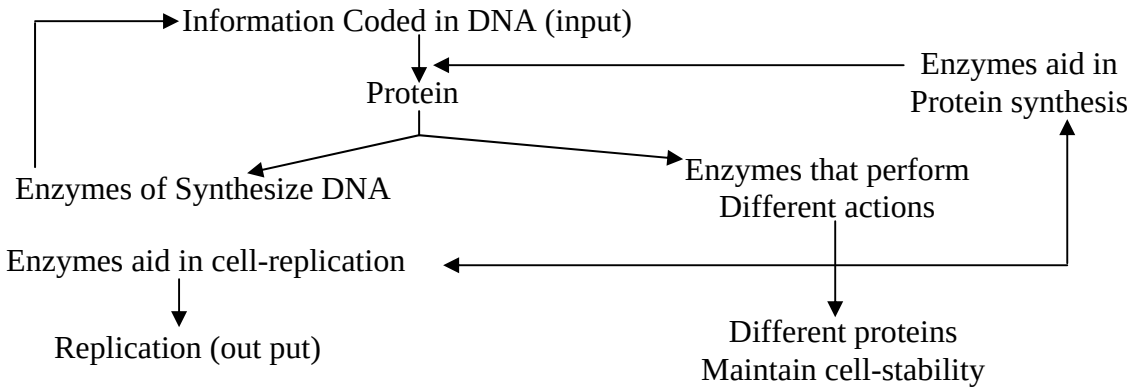
Intelligence is considered as a property of living beings. But the term living is often misleading. Generally it is thought that 'living' means something with consciousness. But when someone is sleeping, he is unconscious but living. So we should search in somewhere else to find this answer.

If we combine all the properties of living beings, we find the most fundamental & striking property of a living being is the ability to replicate. So by this definition, cell is the smallest living thing because no molecule inside the cell is known to replicate independently, though DNA replicates inside the cell, but not outside. A cell can replicates even outside the body (in cell culture). So cell is the smallest living thing known yet.

Replication : A closer look

So, now it seems that replication is the most fundamental property of all living things. But is it truly 'fundamental'? (Fundamental means independent). The answer is hidden in the mechanism of replication.

Cell-replication is a complicated process that requires involvement of many enzymes and complex molecular interactions governed by laws of physics & chemistry. The whole process is controlled by DNA, the information storage system of cell. All proteins including the enzymes those are necessary for cell-replication & even for DNA replication, are coded from DNA. So, it is the 'information' that gives the cell 'the power to replicate'. So "information storing capacity" is the more fundamental property of living beings.



By this definition of living things, the cells which are devoid of replicating ability (eg. neurons), are also included in the list of living beings. So, this concept is more accurate, so, DNA is the smallest living entity as it can store information (which is more fundamental than replicating ability) & also express it.

Though other proteins or chemicals contain information, have power of combination, communication & altering different reactions in an apparently directed way. But basically their interactions are all controlled by DNA. So, even if we consider them as 'living', their livingness is dependent on DNA. So, only DNA is the independent & living thing inside the cell.

Evolution of Information Storage System

DNA information system is formed by 4 nucleotides which code for proteins. Proteins are able to perform diverse types of function. Now a problem arises when we consider evolution of this system.

Theory of evolution (Darwinism) states that variation occurs randomly in DNA (by mutation) and useful variations are selected by natural selection. The 'useful variation' means a

mutation that result in some ‘gain in function’. Now let’s have a closer look to this assumption.

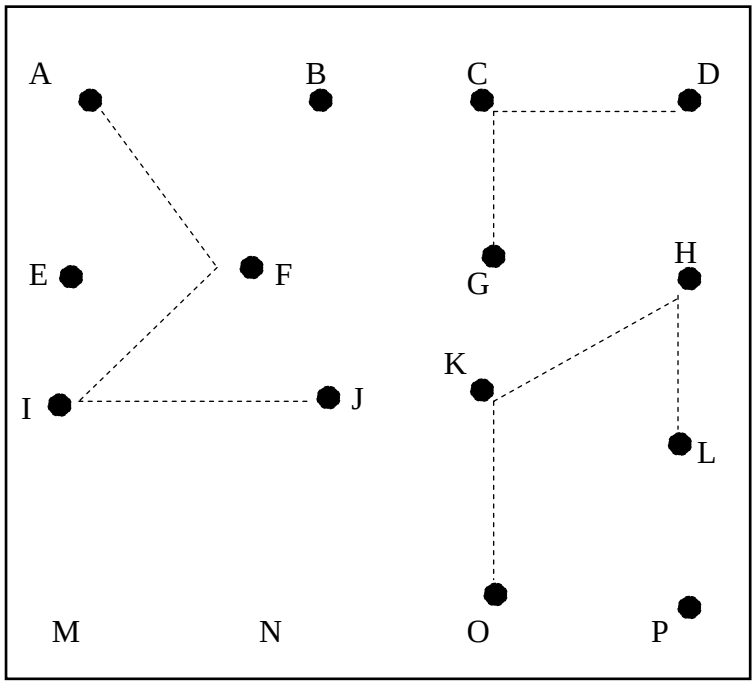
Suppose a gene codes for a protein P_1. Now mutation of that gene results in the formation of a new protein P_2 . ‘Gain in function’ means that P_2 will be able to do the work better than it was done previously by P_1. The primary condition for this event to occur is that both P_1 and P_2 is to be functional.

Now suppose the length of P_1 is constant. In this condition suppose A number of protein (length is same as P_1 but primary structure is different) is functional. Also B numbers of such proteins are non-functional. By statistics it has been shown that the ration B/A is so big, that formation of a new protein with advanced function is practically not possible. This ratio B/A increases with the size of the peptide chain. (For e.g. – for cytochrome oxidase the ratio B/A is 10^{120}) (1)

So, now it is obvious that ‘gain of function’ can not be a random process. It must be a logically directed process (link: http://www.detectingdesign.com/steppingstones.html). Now this situation gives rise to a trickier question – what is the source of logical sense in DNA?

Logic and Information

The relation between logic & information in an intelligent system (i.e. human brain) can be explained by the following diagram.



There are 16 bits of information (Represented by the points A, B, C, D…) logic is formed when similar kind of information are joined together, (In this diagram [AFIJ], [DCG] & [OKHL] represents logic)

By convention, a more intelligent

or complex system means that it is more logical. Clearly logic depends on two things.

(i) ***Amount of Stored Information:*** If amount of stored information is low or high there will be less or more chance of advanced logic formation e.g. Information content of the brain of a new born is very low, so, his / her logical sense is also poor.

(ii) ***Co-ordination of Information:*** This part is also important but often overlooked by us. The relevant information must be coordinated to form a logical idea. This thing is observed only in living beings, (i.e. a super computer may contain lot of information but devoid of logical sense as it can not correlate between them).

As in the above diagram, when "A" is getting connected with "F" it need not search all the points (B, C,D,E……..) to check whether they are relevant or not.

This property (to co-ordinate between two or more relevant information) makes living beings different from any electronic system. This property is thus turned as 'intelligence'.

Measurement of Logical Sense in a System

The following method of estimating the logical sense can be applied to any biological system. Suppose there is total (N + 1) bits of information (In the above diagram N + 1 = 16) so one point can be connected with rest "N" number of points.

Suppose in reality, it has been found to get connected with only "n" number of points. (In the above diagram n = 1). In an ideal logical system "n" must be 1 because one information must be connected with the most relevant one.

So, intelligence of that system, should be $I = f\left(\frac{N}{n}\right)$ if n = N then 'I' must be 'O' [The system is devoid of intelligence] $\therefore \quad f(1) = O$

So the possible equation: $I = C.\ln\left(\frac{N}{n}\right)$. Now the above equation is for one step (i.e. for 2 point logic). If no. of points in a logic is 'S' [In the logic (DCG), S = 3] then

$$I = C\ln\left(\frac{N}{n}\right)^{S} = C.S.\ln\left[\frac{N}{n}\right] \rightarrow (1)$$

So Intelligence of the above system with respect to the logic (OKHL) would be - I_{OKHL} = C.4ln15 [Cs a constant that is expected to be different in different biological systems]

=C.10.8 (approx)

Now, one thing is to be remembered. All the ways of connection may not be possible due to other laws of nature (e.g., law of thermodynamics). So in that case Intelligence is to be measured only with the possible ways (N_P or n_P)

$$\therefore\ I = C.s.\ln\left[\frac{N_P}{n_P}\right] \qquad \rightarrow \qquad (2)$$

Entropy of a Logical System

According to Brillouin(2), Entropy of any system is given by - $S = k\ln\Omega$

S = entropy of that system.

K = Boltzmann's constant.

Ω = Number of arrangements, possible.

Now let's look back to our previous intelligent system. When intelligence is present No. of possibility is reduced to 'n' from 'N'.

So Reduction in entropy is given by –

$$\Delta S = K\ln\Omega_1 - K\ln\Omega_2$$

$$= K\ln\left[\frac{\Omega_1}{\Omega_2}\right]$$

$$= K\ln\left[\frac{N}{n}\right] \qquad \left[\begin{matrix}\Omega_1 = \text{No of ways before intelligence is applied} = N\\ \Omega_2 = \text{No of was after intelligence is applied} = n\end{matrix}\right]$$

$$= K.\frac{I}{C.S}$$

$$\therefore \Delta S\ \alpha\ I \quad \rightarrow (3)$$

So, presence of intelligence decreases the entropy of a biological system & decrease in entropy is directly proportional to the intelligence of that system.

Intelligence and Evolution

Now, let's consider the previous problem (gain of function mutation of cytochrome oxidase B/A ratio of which is 10^{420}. If it is to be possible then intelligence of that system is to be –

$I = C.S.\ln 10^{420}$

$= 420.C.S.\ln 1$ [As it is a point mutation, S = 1]

$= C.420.\ln 10$

$= C.967.1$(approx)

Now this mutation seems no longer impossible. So a sense of logic is found to be working in living molecules e.g. DNA.

Now, if it is assumed that some how intelligence exists in DNA, two more fundamental questions arises eventually.

(i) What is the source of intelligence in DNA?

(ii) From where did it come?

These two questions will be attempted to be answer in the following sections.

Nature of intelligence in DNA

Before analyzing the nature of intelligence in DNA, let's recall the known facts.

i) It is an independent property almost exclusively found in DNA [Also in RNA in case of some viruses & in proteins in prions]

ii) It differs from species to species.

DNA molecule is composed of nucleotides, arranged in a double helical pattern. Primary structure is different from species to species giving rise to 'variation'. But in all cases two thing are common –

i) It is always made up of nucleotide.

ii) They are always arranged in a double helical pattern.

Both of the above conditions are essential. Otherwise DNA build of other chemicals would also be found in nature & patterns other than double helix would also be observed. Now how these two things (Nucleotide & its spatial arrangement) give rise to intelligence? There is only one logical solution to this problem.

Let’s think intelligence is property of nucleotide. But total intelligence of DNA molecule is also dependent upon the arrangement of those nucleotides. Here arrangement acts as an ‘operator’.

The term ‘operator’ should be explained here. When some quantities are added together but the total value differs from the sum of their individual magnitudes, it can be said that during addition an operator was working. For example in case of vector addition magnitude acts as operator. So in intelligence addition, arrangement is the operator.

Arrangement as an operator – Significance.

So now let’s imagine a molecule with intelligence. It has a specific conformation (spatial arrangement of atoms) or arrangement only for which the component atoms are able to express intelligence.

Now what does this ‘arrangement’ actually signify? It actually controls the interaction of that molecule with the environment. If carefully observed, only the following properties of a molecule are responsible for such interaction.

i) Size
ii) Shape
iii) Mass
iv) Distribution of charge over surface.
v) Flexibility in structure.
vi) Affinity to other molecule to form chemical bond etc.

All the above properties are determined by two things .

i) The primary structure i.e. the liner position of atoms.

ii) The spatial arrangement of them.

As human being interact with each other through particular language, let's think that arrangement is molecular language which is responsible for its interaction with the other components in a certain bio system.

Now a bio-system works perfectly as long its individual components interacts with each other in a specific manner. Again that because their languages matches with each other or in other word all of them must speak in the same language.

Now don't get confused. They "speak" different things at different times (They are different molecules) but in the same language so that they can function as a group & the system smoothly goes on.

Obviously the language (though it is an imaginary one) is specific for that bio-system only. Though there is similarity between the languages of different bio-system (due to their common origin), they are essentially different from each other. That's why one functional molecule in a system becomes functionless when it is introduced in a different system. It also becomes functionless, when its structure is slightly changed. In both cases the language in which it interacts with the system get altered & it loses its function partially or completely, depending on the degree of alternation.

Homochirality problem – a possible solution

Homochirality remains an unsolved issue in biological science. It refers to the fact that in biological system a particular molecule exist only a specific chiral form. For example active forms of amino acids (except d-serine) always exist in L-form. Well, now let's try to solve this puzzle with the idea we have got in the last section.

Any amino acid can exist in two forms L-form & D-form. Now if in a protein some L-amino acids are replaced by their counterpart i.e. D-amino acid, the primary structure will still remain same. But obviously the molecule will suffer from a serious language alternation

because spatial arrangement of atoms will no longer remain the same. Eventually the protein will lose it function.

Actually in biological system a molecule is recognized by its language. So for such a system L-Alanine & D-Alanine are two completely different molecules.

Though total number of amino acids in nature is very big (several hundreds), may be in thousands also, only 20 standard amino acids are expressed by eukaryotic genome. Number 20 is very low, when compared to the huge number of non-standard amino-acids. Actual number is not known but it is close to one thousand. To make the calculation simple, let's suppose that there are total one thousand amino acids present in nature. Now we have to consider both L & D form so actually 2 thousands amino acids are there.

Now among 2 thousands amino acid only 20 amino acids have been choose by nature (1 in hundred), so definitely there was a long & hard core competition between those amino acids for natural selection. (It is like 2000 students are competing in an entrance examination in which only 20 seats are available). Now it has been experimentally proved that L-amino acids more suitable in biological system than D-amino acids (as the L-form is more stable due to weak force). May be that this difference is not great but it really matters when the chance of selection is only 1%. That's why only L-forms are found in standard biological systems (though exceptions are there).

A Deeper Search

As DNA is made up of nucleotides, nucleotides are made up of different atoms. So like that of DNA, it can be assumed that atoms are intelligent & their arrangement within nucleotide acts as an operator. This assumption is logically supported by the following evidences.

(i) Similar atoms (carbon, oxygen, nitrogen) with different arrangement fail to produce intelligence.

(ii) All the nucleotides & even the unusual nucleotides (observed in nature) have adopted similar spatial structure (purine or pyrimidine, Ribose sugar & phosphoric acid).It indicates the importance of arrangement.

ORIGIN OF LIFE: A LOGICAL APPROACH

Though the exact pathway of "Abiogenesis' is still unknown, it is thought to be happened through chemical interaction. Calculation has shown that the first living organism required minimum of ~ 256 + genes & ~ 239 + proteins. Though this number varies in different studies it has been clear that it was impossible to form the first living system by random interactions between molecule & if it is possible than it would take an abnormally long time (many times than the age of our universe). This problem can be solved if we take the following line of thinking.

Before getting into the mathematical approach let's think about an imaginary situation. Suppose there is an island with plenty of foods, water, woods & other thing necessary to live. Now some intelligent animals with no knowledge (i.e. information content is zero but they are intelligent) is dropped in that island. Will they ever be able to turn that island into a modern city like New-York?

The answer is yes. There is a possibility of occurring so. Because this thing has actually been happened on Earth (which is the island) & those intelligent animals are nothing but human beings. But it should be remembered that this advancement requires two things –

(i) Those animals must be intelligent.

(ii) A long time is required.

Now, we have to compare this situation with the pre-biotic era. Let's replace that island with the prebiotic ocean of earth & those intelligent animals with non-living molecule. Will they be ever able to make a cell? (That is even more organized than a city).

The answer is again yes because this thing also has been happened on earth. So the previous two conditions must be true in this case also. That means some intelligence was present in those molecules & they had taken a long time to form the first cell. Once the cell was formed the advancement (i.e. evolution) started to become quick (As like our modern civilization, rate of development is obviously increasing). So intelligence was there in those molecules, now let's turn into mathematics.

Now let's think about a simple situation. Suppose a biological system is to be formed & it consists of N number of functional molecule arranged in a specific manner. Now in the absence of intelligent suppose 'n' number of molecules can be correctly arranged by random interaction in unit time. [Here unit time is not 1 sec. It is obviously a longer period like thousands of years or like that]. So total time required would be $\frac{N}{n}$ unit time.

Now let's think that all the molecules are intelligent. The total intelligent of the system at an instant is a function of the some of the intelligence of correctly arranged molecule & that directly control the rate of addition of new molecules in the system in the correct order until the system of N molecule is completely formed.

Suppose at an instant the speed of formation is u that becomes V after unit time. Also let's think that at that instant the intelligence of that system is I which is a function of the sum of the intelligence of individual molecules as previously mentioned. Suppose at that instant there is 'm' number of molecules in that system with average intelligence i. so –

$I = f(mi) = k_1 \times m \times i$ (suppose)

It must be a positive function i.e. 'I' increases with the increase in 'm'

Now let's think that 'u' is the minimum speed of formation which is acquired by the random interaction (without intelligence). Now, once 'm' molecule is gained in the system intelligence started to work (increase the speed of formation to 'V' from 'u' in unit time.

So,

$$V - U = k_2 I$$
$$= k_1 \times k_2 \times i \times m$$
$$= k_1 \times k_2 \times i \times u \times t$$
$$\Rightarrow \frac{v-u}{\Delta T} = \frac{k_1 \times k_2 \times i \times u \times t}{\Delta T} \quad [t = \text{time before intelligence started to work}]$$
$$\Rightarrow f \propto \frac{t}{\Delta T} \longrightarrow (4) \quad [f = \text{accelaration}]$$
$$\Rightarrow f \propto t \ [\text{if } \Delta T = 1 \text{ i.e. it is thought as unit time for easy calculation}] \rightarrow (2)$$

So acceleration depends on the previous time which is positive, so acceleration is present.

Now, let's repeat the, whole thing for the second unit time. After 2nd unit time suppose the

$$V' - v \propto \Delta m$$
$$\Rightarrow f' \propto \Delta m$$

speed of formation becomes V so, $but\ \Delta m \propto \left(V + \frac{1}{2} f\right)$

$$\Rightarrow f' \propto \left(v + \frac{1}{2} f\right) \qquad \rightarrow (5)$$

The above relation actually holds true for every instant of formation & it proves that the acceleration is also increasing.

Also, -

$V \propto \Delta m$ at an instant

so, $-(f' - f) \propto m \Rightarrow f'' \propto m \qquad \rightarrow \qquad (6)$

$f^{//}$ = increase in the rate of acceleration

So, acceleration is not only increasing but rate of increase in acceleration $f^{//}$ is also increasing (As m is increasing).

Alternative Calculation

Now at any instant, if the speed of formation is V is proportional to the amount of already formed molecule, it is given by --------

$$V = u(k + 1)^t \text{ [After t sec]}$$

So, the Amount formed at t^{th} unit time would be ----

$$M_t = u(k + 1)^{t-1}$$

[It has been assumed that amount of formation in a unit time is function of the intelligent, already present in that system. For simplicity of calculation, it is also assumed that $m_i = K\sum_{0}^{i-1} m$ it means that amount formed at i^{th} unit time is proportional (with a positive constant K) to the already formed system at (i – 1) unit of time.

u is the amount which was formed at the first unit of time by random interaction (in the absence of intelligence)]

So, amount of the system formed after $T^{/}$ unit of time.

$$m = u\frac{(k+1)T'-1}{K} = \frac{u}{K}\left[(k+1)T'-1\right] \qquad \rightarrow (7)$$

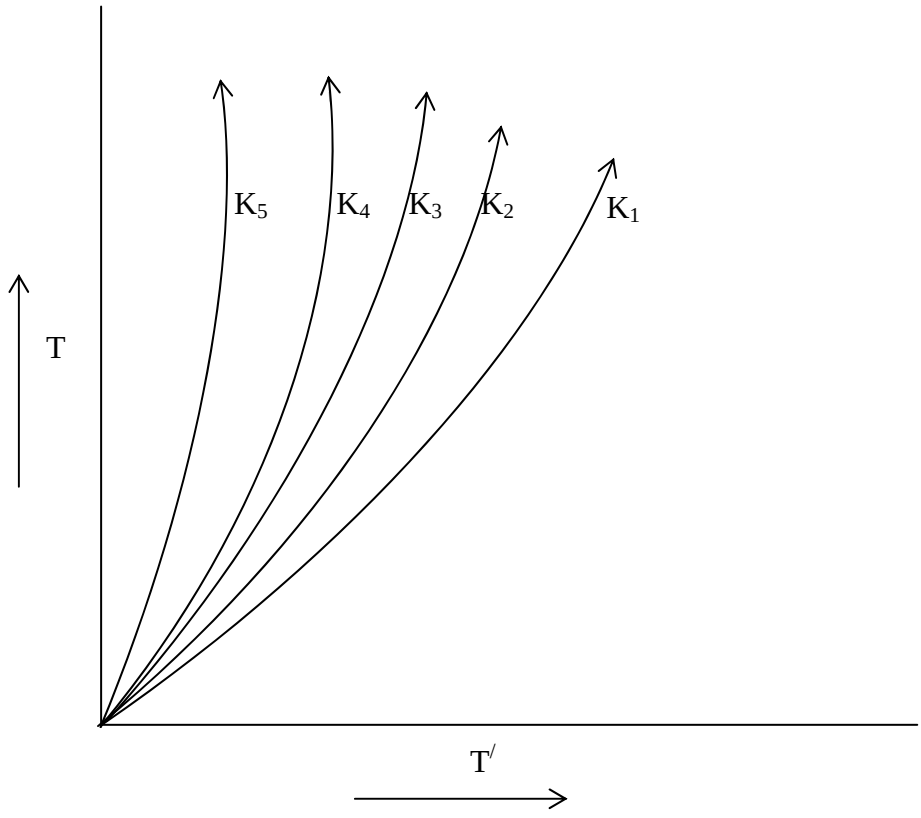
Now, in the absence of intelligence the speed of formation would be u for the whole time. Now if it takes T time then ----

$$m = uT$$

$$\therefore uT = \frac{u}{K}\left[(k+1)^{T'}-1\right]$$

$$\Rightarrow T = \frac{(k+1)T'-1}{K} \qquad \rightarrow (8)$$

From the above relation, it is obvious that for positive values of K(which is always positive), $T^{/}$ is always smaller than T. The nature of the curve is like following one.



The steepness of the curve depends on the value of K. The curve is getting steeper with increasing value of K.

$K_5 \rangle K_4 \rangle K_3 \rangle K_2 \rangle K_1$

So, now we can say that in intelligence directed manner, formation of any bio-system would take drastically smaller time to form. The time difference not only increases with K but also with T (the predicted time for formation of such bio-system without intelligence) which is obviously very long. For example ---

Without intelligence a bio-system was estimated to get formed in 10^{80} sec. But in the presence of intelligence if it would take T' sec than ---

$$10^{80} = \frac{2^{T'}}{1} [\text{Assuming k} = 1]$$
$$\Rightarrow T' \cong 4 \text{ minute } 25 \text{seconds} (\text{approx})$$

But in reality obviously formation of such system would take more than 4 minutes. Actually value of K get reduced many folds due to several reasons.

(i) Presence of unnecessary molecules in the environment & their interaction with the growing bio-system.

(ii) Necessary molecule might be absence in the environment for a period of time.

(iii) Disruption of arrangement of already formed system due to natural forces.

The above factors reduce both u & K whose original working values are therefore unknowable.

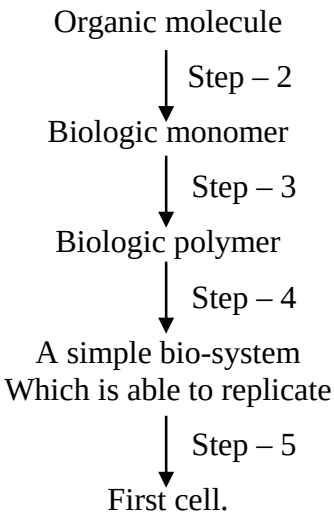
So, in the presence of intelligence origin of life becomes possible though the exact pathway is hard to find out.

Origin of Life: A Proposed Model

Lot of models has been proposed to unravel the exact pathway of life formation. Though no model is universally acceptable, a general outline is always followed (As below) .

Inorganic molecule

↓ Step – 1



To explain each step, different models have been proposed separately. All of them have some drawbacks, which are overcome by the others. So our objective will be to focus on their common drawbacks.

i) No model could ever explain step – 5 successfully because commonsense tell us that the first replicating system could not be cell, rather a simple bio-system that is grown up (by collecting specific monomer/polymer/molecule from environment) & then mechanically divided & the cycle repeats. But how this more mechanical process could generate a cell which is a specific carrier of information & enormously organized too?

ii) Step – 1 to step – 4 is actually chemical evolution. But as there was no replication Darwinism did not work. So how could they evolve anyway?

To solve the above problems we need to combine the intelligence hypothesis (proposed in this article) with Darwinism.

In the past sections it has been argued that a bio-system may be intelligent (it can be measured by equation 1). But actually it needs some direction that actually indicates the function of the system. It means that when the system is random, it is also functionless. But when it becomes non-random it also acquires some functional ability or some special property that makes it different from other similar bio-system. That property forms the base on which Darwinism actually can work.

Step – 1 & Step – 2 $\longrightarrow$ Physical Stability

Step – 3 ⟶ Utilization of energy

Step – 4 ⟶ Replication (it is nothing but a basic tool to maintain an unaltered form even when the single system is destroyable.).

It is notable that up to step – 3 , physical stability was the major criteria of natural selection. But as the complexity increased, the criteria changed to become 'Replication' or ability to reproduce. Emergence of this property possibly allowed the system to become more advanced because now it becomes free from the fear of destruction by mere structural change as if it would even destroyed by attempting a new change in structure / function, its copy remains, provided it had replicated before getting attempting to do so. Thus property of replication not only made the system more stable but it also made a broader platform on which natural selection i.e. Darwinism could work better.

Step – 5 ⟶ information storage system.

This was the final property that was possibly formed to make the functions of the bio-system (i.e. replication, utilization of energy etc) more accurate. That accuracy made the system more stable. Thus 'information storage capacity' was naturally selected. Now once this property was emerged the platforms for natural selection become even broader.

Once a cell is formed, the direction of intelligent points toward the following

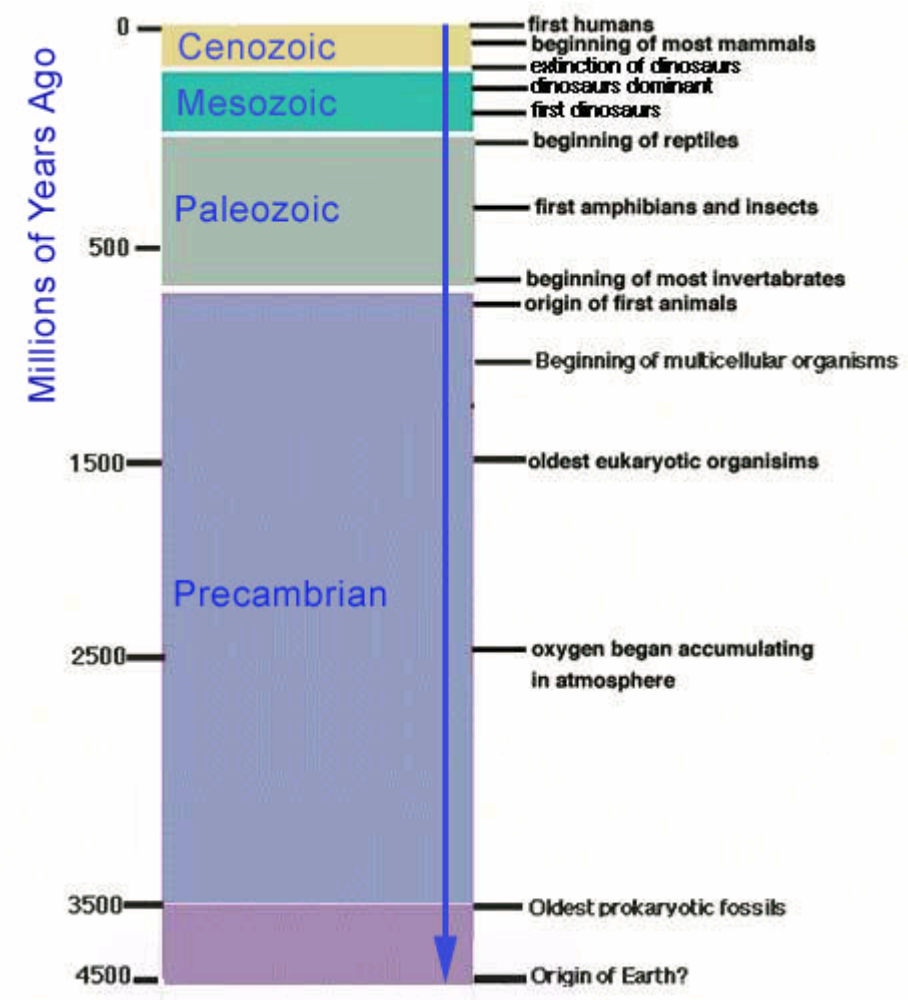
(i) To make the storage system more powerful

(ii) To directly & indirectly increase the stability of the cell.

So, for the origin of life both intelligence & Darwinism was required. But it needed to be directed in the right way by Darwinism.

Speed of Evolution:-

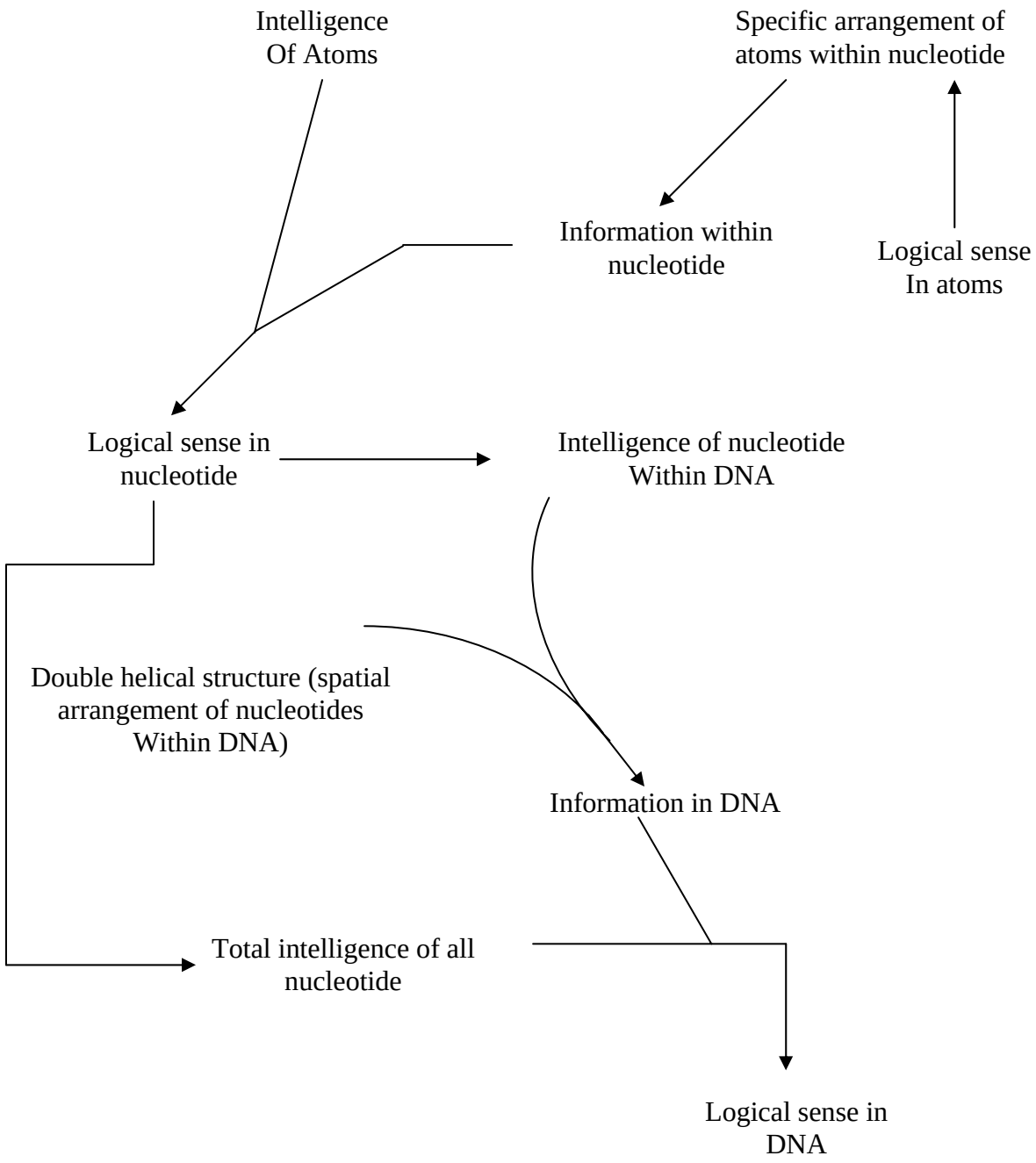
The rate of formation of a bio-system in pre-biotic era can be replaced by rate of evolution (formation of more complex & advanced organism), with other assumptions unaltered. It seems that the rate of evolution is increasing (Relations (6)) though that increase in speed is lower than the expected value due to environmental noise & other problems. This increase in spot is supported by the fossil records. (3).



Cambrian Explosion: -

It refers to an ancient event when a huge biological diversity appeared within a very short period of time but remains unchanged for the next longer period of time. It can be explained by our model easily. During the first unit of time, Rate of formation is slow until a threshold value of intelligence appeared. Once that intelligence was appeared it's speed suddenly increased before checked by other factors.

Problems and discussion



Now, if we assume that atoms are intelligent, it creates confusion. But it should be kept in mind that only intelligence without information can not be expressed (As there is no logical sense). As it can not be expressed, it can not be detected by experiment. (4)

Suppose, there is no existence of positive or negative charge in our world. Now if from an alien world a negatively changed particle comes to our world, it will not be possible for us to detect that property because simply that property (negative charge) of that particle will not be expressed anyway.

Intelligence is expressed by decreasing the entropy of the system. (See equation 3). As at atomic level (interaction between atoms) laws of physics & chemistry allows very few numbers of possibilities to occur, entropy is almost zero. So it is not possible to decrease it further thus expression of intelligence is also impossible.

Two basic questions arise with this assumption. (Atoms are intelligent).

i) Why is it not possible to create life in laboratory?

ii) If all the atoms are intelligent, why life is present only on earth?

The first question can be answered, if we carefully observe the equation (8) irrespective of any value of K, $T^{/}$ will be one, when T is one. It means that for the first unit of time, intelligence does not work & so it takes the same time as that of non-intelligent random interaction. As obviously in this case unit of Time is actually a very long period (thousands of years for example), creation of life in laboratories is not possible.

Before answering the second question we must remember that there is no proof that life exist only on earth & possibly it exists in many other planet (yet existence of life is not a very common incidence). The thing which is absolutely necessary for the formation of life is the molecular interaction which requires liquid medium. As plenty of such medium (water) was present on early earth, creation of life was possible.

Nature of intelligence in Atom

Now it is difficult to say about the origin of intelligence in atoms. At least following things can be assumed on the basis of observed facts.

(i) Most possibly the intelligence arises from the internal structure of atom, internal structure of atom is a mysterious area & lot of things are still to be found out.

(ii) If intelligence is imagined as a physical quantity, it is neither scalar, nor vector. It is not scalar because – (1) an operator is present (Rule of conservation does not work) &(2) it is not vector because – The operator is not magnitude, it is the arrangement, which must be maintained with finest accuracy.

Now, according to our present day knowledge, quark & electron are most fundamental particle without any internal structure. These two things also built other particles. (Proton, neutrons etc) so by logic, they should posses same logic (expressed only at that level). It means that with intelligence, they also carry some information within them.

So, at the level of fundamental particle, as now arrangement is required no operator, logical sense should be a pure scalar quantity that would follow the law of conservation only that much we can say today. Hope we will get a more clear view in near future.

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