Alternative Ideas

Alternative Ideas

A different initial genetic substance + genetic takeover

e.g., clay life

Panspermia

Various versions

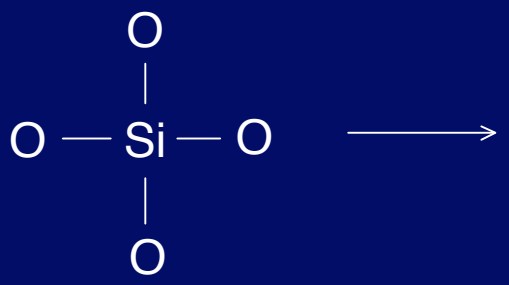
Creationism

Clay Life

A. G. Cairns-Smith

Silicate Life? Early Genetic Material

O = Si = O but O can make another bond instead



great variety of minerals

Layers - clay

Also occasional impurity (Al, Mg, …)

Can grow by adding dissolved material

Tends to copy pattern of impurities in adjacent layers.

Could this be a kind of reproduction?

Defects - different impurity, … (mutations?)

Sheets can separate - move - and then "reproduce"

Advantages	Problem
Clay clearly present	How to get to
Simpler genetic structure	life as we know it
Crystal growth occurs naturally	

Clay Life $\xrightarrow{?}$ Life

Clay life begins to synthesize, use “organic” [carbon] molecules

Clays do have some catalytic activity

Genetic takeover

organics $\longrightarrow$ protein/RNA mechanisms

Clay discarded

Tests

1. Surviving clay life - unlikely
2. New clay life - maybe in some places
3. Demonstrate in lab

Not much further development of this idea.

Focus on Energy

G. Wächtershäuser

Inorganic - organic connection

FeS_2 (Iron pyrite)

Attracts negatively charged molecules

Surface catalysis provides energy via formation from

$FeS + H_2S$

Scene is hot sulfur vents on sea floor

Some recent successes in simulations

Amino acids formed peptide bonds

Panspermia

- Life arose elsewhere and was delivered here
  - Original idea was bacterial spores
  - Hoyle and Wickramasinghe
    - Life originates on dust grains, comets, …
  - May be revived (meteorites from Mars)
- Directed panspermia
  - Crick and Orgel (tongue in cheek)
  - Earth seeded by intelligent ET

Creationism

- Traditional biblical literalism
- Intelligent design
  - Seeks evidence of design in complexity
  - Current version of creationist movement
  - Hoyle and Wickramasinghe later ideas
    - Life designed by silicon chip
    - Where did the chip come from?
- None of these are scientific theories
  - The key is whether they can be tested

From “Scientific Creationism” by Henry Morris

Uniformitarianism	Bible
Matter existed in the beginning	Matter created by God in the beginning
Sun and stars before the earth	Earth before the sun and stars
Land before the oceans	Oceans before the land
Sun, earth’s first light	Light before the sun
Contiguous atmosphere and hydrosphere	Atmosphere between two hydrospheres
Marine organisms, first forms of life	Land plants, first life forms created
Fishes before fruit trees	Fruit trees before fishes
Insects before birds	Birds before insects
Sun before land plants	Land vegetation before the sun
Reptiles before birds	Birds before reptiles
Woman before man (by genetics)	Man before woman (by creation)
Rain before man	Man before rain
“Creative” processes still continuing	Creation completed
Struggle and death necessary antecedents of man	Man, the cause of struggle and death

Myth (Mythos)

Revealed truth unquestioned

Two strands in Creation Myths:

Creator "Western"

Spirit in Matter "Eastern"

Creationism

spontaneous generation

self-organization of matter

Science (Logos)

Provisional truth

Skepticism essential (falsifiability)

Method important

Interplay:

Theory

Experiment/ observation

Paradigm

Chemical Evolution

related?

Artificial Life?

- Polio virus constructed from “scratch” in 2002
- Have they created life?
- Viruses are parasites, but “protolife”?
- Entire bacterial genome (not the bacterium) constructed from scratch in 2008
  - 582,970 base pairs
  - Next goal is to insert in living organism and have it take over. May happen this year.
- Could we create a bacterium from scratch?
- Far too complex for current abilities

Exotic Life Forms?

Antidote to Earth Chauvinism

1. Different organic molecules (e.g., PNA)
   possibility of life based on other polymers

2. Not based on Carbon
   Silicon (Si) instead of Carbon?
   (also 4 bonds)
   & more (135 ×) more abundant on Earth

Negatives for replacing carbon with silicon:

a. C - C bond $2 \times$ stronger than Si - Si

b. Si - O stronger than Si - Si

forms silicates, not .. Si - Si - Si …

c. C forms multiple bonds (e.g. C ≡ N)

Si rarely does

d. C + O forms CO or CO_2 (gas - further reacts)

Si + O $\longrightarrow$ SiO_2 - silicate rocks

$\Rightarrow$ Si unlikely to replace C in “organic” molecules

but could forms of SiO_2 produce clay life?

3. Other Solvents

Earth: Liquid water 273-373 K

Alternatives:		T_{freeze}	T_{boil}
Ammonia	NH_3	195	240
Methyl Alcohol	CH_3OH	179	338
Methane	CH_4	91	109
Ethane	C_2H_6	90	184

Water is better solvent

Also better for temperature regulation

But others could play a role in colder zones

extend CHZ?

4. Non-chemical life?

Disembodied intelligence

Black cloud life?

Other forces

Strong nuclear force? $\tau \sim 10^{-15}$ s

Gravity?

Estimates for f_ℓ

- Possible range is very large
  - Perhaps 10^{-6} (one in a million) to 1 (all)
- Arguments for large value
  - Life part of overall evolution in complexity
  - Arises naturally from interplay of forces

Estimates for f_ℓ

- Arguments for small value
  - May need more than liquid water
    - Large tides, so large moon
    - Dry land (for polymerization)
  - Life may be a fluke
    - A rare statistical event

Can we estimate f_ℓ from early origin of life?

Very ancient microfossils (now disputed)

$\Rightarrow$ Life arose as early as 3.8×10^9 yr ago

[soon after end of heavy bombardment]

Lineweaver & Davis argued:

Early origin $\Rightarrow f_\ell > 0.33$

For suitable planets older than 1×10^9 yrs.

Statistics from <u>one</u> example!

Others have disputed this conclusion

What is your choice and why?

- The most uncertain factor so far (f_ℓ)
- Think about various ideas for origin of life
- Put together a plausible story for the origin of life
  - Can use parts of various ideas, but need to be consistent.