• what is life?
• properties of living things
• definitions
• life on Mars?
• the biosphere - Gaia
• are viruses alive?
• virtual life?
• origins of life
• “this view of life”

1943: Physicist Erwin Schrodinger suggests an “aperiodic crystal” directs maintenance of localized ‘negative entropy’ & invites other physicists into biology

1953: Watson & Crick accept the invitation; figure out molecular structure of DNA, which suggests its function.

1995: Sagan & Margulis honor Schrodinger & try to foster a more holistic view of self-maintenance – Gaia Hyp: is ‘Mother Earth’ alive?

Life’s but a walking shadow, a poor player
That struts and frets his hour upon the stage
And then is heard no more: it is a tale
Told by an idiot, full of sound and fury
Signifying nothing.

(Shakespeare V.v.)

“...almost any child perceives that a dog is alive but a rock is not.”

Science is about things we can measure objectively; “I know good art, pornography or life when I see it” is not very scientific!

Chao (2000) – evolution is the fundamental property; other properties derivative (nested).

“...close to the chemical equilibrium state, as determined by chemistry and physics. ...
If the planet held life, the metabolic activities of life-forms would result in an atmosphere far from the equilibrium state. {low entropy}

From Gas to Gaia:

In the mid-1960's, Dr James Lovelock was approached by NASA, who asked him for help in searching for life on Mars. Lovelock proposed some physical tests… analyze the composition of the planet's atmosphere.

If held no life, the planet should have an atmosphere close to the chemical equilibrium state, as determined by chemistry and physics.

(J.E. Lovelock, A physical basis for life detection experiments, Nature 207 (1965), pp. 568–570. )

If the planet held life, the metabolic activities of life-forms would result in an atmosphere far from the equilibrium state. {low entropy}

Lovelock examined the Martian atmosphere and found it to be in a state of stable chemical equilibrium, {high entropy} while the Earth was in a state of extreme chemical disequilibrium. {low entropy}

The scientists concluded that Mars was... almost a decade later the Viking 1 and 2 landings conformed their conclusion.
Lovelock began to think that such an unlikely combination of gases such as the Earth had indicated a homeostatic ability of the Earth biosphere to maintain environmental conditions conducive for life.

The novelist William Golding, Lovelock's neighbor, suggested he call the control system Gaia, after the ancient Greek Earth Goddess.

"Gaia, as a total planetary being, has properties that are not necessarily discernible by just knowing individual species or populations of organisms living together."

James Lovelock - *The Ages of Gaia*

The Gaia Hypothesis is definitely holistic! … and rests on which criterion for life? {See the Evolution Connection at end of C&R Ch 54 – critique this Gaia idea.}

"In The Selfish Gene I constantly emphasized... genes as the central units of natural selection. Anything that is self-replicating is fair game for natural selection." Richard Dawkins, in C,R,&M (5th ed) pg 412-413.

A virus is a genome enclosed in a protective coat. {see C&R ch 18} Hyp: viruses are obligate parasites of cells that originated as mobile ('selfish') bits of host cell nucleic acids, possibly plasmids or transposons ('jumping genes') (If viruses evolved from living cells, can non-living things evolve from life?)

An isolated virus ... unable to replicate its genes or regenerate its own supply of ATP. Yet it has a genetic program written in the universal language of life.

Try substituting: [human for virus] {see C&R ch 18}


The team behind the announcement said that it demonstrates the risk of synthesizing viruses that are created from just their genetic information. "For example, other viruses are [harmful]."

Search for a definition of life may be a never-ending quest. Production of synthetic virus raises new questions THERE is no easy answer to the simplest question raised by today's announcement that scientists have made a synthetic virus in a laboratory: what, exactly, is life? Prof Eckard Wimmer, head of the team that built poliovirus from scratch, said: "Humans have not reached a consensus on how to define life and they never will." see: Editorial: Meanings of 'life.' Nature 447, 1031-1032 (28 June 2007)
“Evolution accounts for life’s unity and diversity” (C&R pg 15)

- what about life’s origins?

When the earth formed some 4.6 billion years ago, it was a lifeless, inhospitable place. A billion years later it was teeming with organisms resembling blue-green algae. How did they get there?

But many scientists take it seriously. How, in short, did life begin? How, in short, did life begin?

If you want to find alien life-forms, you may only need to catch a plane to East Lansing, Michigan. The aliens of East Lansing are the theory of natural selection suggested an answer.

The theory implied that all current life-forms could have evolved from a single, simple progenitor – an organism now referred to as LUCA. They have no DNA. These are digital organisms – strings of commands akin to computer viruses. Billions of them are quietly colonizing a cluster of 200 computers in the basement of the Plant & Soil Sciences building at Michigan State University.

In private correspondence…he suggested that RNA might well have come first and established what is now called the RNA world – a world in which RNA catalyzed all the reactions necessary for a precursor of life’s last common ancestor to survive and replicate.

Darwin…posited in the final paragraph of The Origin of Species that "the Creator" originally breathed life "into a few forms or into one." Then evolution took over. "From so simple a beginning endless forms most beautiful and most wonderful have been, and are being evolved."

In private correspondence…he suggested life could have arisen through chemistry, "in some warm little pond, with all sorts of ammonia and phosphoric salts, light, heat, electricity, etc. present."

For much of the 20th century, origin-of-life research has aimed to flesh out Darwin’s private hypothesis - to elucidate how, without supernatural intervention, spontaneous interaction of the relatively simple molecules dissolved in the lakes or oceans of the prebiotic world could have yielded life’s last common ancestor.

One can safely infer that intricate features present in all modern varieties of life… all living things consist of similar organic (carbon-rich) compounds. … the proteins … are fashioned from one set of 20 standard amino acids. … carry their genetic information in nucleic acids - RNA and DNA - and use; … we can infer that our last common ancestor stored genetic information in nucleic acids that specified the composition of all needed proteins. … relied on proteins to direct … the reactions required for self-perpetuation.

Hence, the central problem of origin-of-life research can be refined to ask,

By what series of chemical reactions did this interdependent system of nucleic acids and proteins come into being?
If this conclusion is correct, the main task … explaining how the RNA world came into being.

The answer to this … requires knowing something about … the prebiotic soup: the aqueous solution of organic molecules in which life originated.

By the 1930s, Alexander I. Oparin in Russia and J.B.S. Haldane in England had pointed out that the organic compounds needed for life could not have formed on the earth if the atmosphere was as rich in ... as it today.

Oparin and Haldane proposed … that the atmosphere of the young earth, like that of the outer planets, was reducing: it contained very little and was rich in hydrogen (H2) … methane (CH4) and ammonia (NH3).

J.B.S. Haldane was approached by a distinguished theologian to ask what inferences could drawn about the nature of the Creator from the study of His Creation. Haldane replied with his usual terseness: "That He has an inordinate fondness for beetles." - approximately one-fifth of all known species are beetles—350,000 and growing.

In the early 1950s Stanley L. Miller … did the first experiment designed to clarify the chemical reactions that occurred on the primitive earth.

he created an "ocean" of water … an "atmosphere" consisting of methane (CH4), ammonia (NH3), hydrogen (H2) and the circulating water vapor. … a continuous electrical discharge ("lightning"), … yielded many amino acids.

... recent investigations indicate the earth's atmosphere was never as reducing as Urey and Miller presumed. … it seems prudent to consider other mechanisms for the accumulation of the constituents of proteins and nucleic acids in the prebiotic soup.

For instance, the amino acids and nitrogen-containing bases needed for life on the earth might have been delivered by interstellar dust, meteors, and comets. …

some of the organic materials required for life may have arisen in deep-sea vents, the submarine fissures in the earth's crust through which intensely hot gases are cycled.


Years after the Miller experiment, a meteorite that struck near Murchison, Australia, was shown to contain a number of the same amino acids that Miller identified ...

Margulis & Sagan (1995) "Of the six kinds of atoms crucial to life on earth - carbon, nitrogen, oxygen, sulfur and phosphorus - all have been detected in space. Hydrogen is the most common element in DNA, RNA, proteins, fats ... is also the most common element in the universe. Ammonia (NH3) was discovered in interstellar space in 1968. H3CN, cyanocetylene, was detected in 1970. Alcohol (CH3COOH) abounds in the constellation Oria.

Other compounds found both in space and in living things include water, acetylene, formaldehyde, cyanide, methanol, and formic acid."

1999 Kuiper Prize Lecture: Cometary origin of the biosphere.

Delsemme AH ICARUS 146: (2) 313-325 AUG 2000

Most of the biosphere was brought on the primitive Earth by an intense bombardment of comets. This included the atmosphere, (Not the seawater and those volatile carbon compounds needed for the emergence of life. …

If you go back far enough, humans, frogs, bacteria ... share a common ancestor: the last universal common ancestor - LUCA.

The search for LUCA began with the study of ribosomal RNA. Because these sequences have changed so little over time, they are ideal for building family trees, or phylogenies, of evolutionary splits that occurred billions of years ago. So far, efforts to reconstruct LUCA's genes have ended in frustration. … the patterns of ancestry vary depending on which gene you look at. This showed genes had hopped between lineages.

LUCA may have been a last common community. … around 3.5 billion years ago, the modern domains of life would have emerged from the swapping ... with many of the genes from the last common community.

Carl Woese: "I picture genes and their products flowing through a sea of cells."

Of course, finding LUCA would not solve the puzzle of how
**Editor's Summary Nature 445, 369 (25 January 2007)**

**Will the traditional units of biology — the organism and the species — be swept away in the flood of new genomics data?**

... Goldenfeld and Woese argue that, for microbes at least, it could happen. Free-living marine microbes, unlike their lab-grown 'clonal' cousins, are adept at acquiring useful characteristics from a shared pool of genetic material. It's beginning to look as if a genetic continuum, rather than a series of discrete species, is the natural condition in many instances.

# Biology's next revolution


**The emerging picture of microbes as gene-swapping collectives demands a revision of such concepts as organism, species & evolution.**

... the convergence of fresh theoretical ideas in evolution and the coming avalanche of genomic data will profoundly alter our understanding of the biosphere and is likely to lead to revision of concepts such as species, organism & evolution. ... microbes absorb and discard genes as needed, in response to their environment. Rather than discrete genomes, we see a continuum of genomic possibilities, which casts doubt on the validity of the concept of a when extended into the microbial realm.

We foresee that in biology, new concepts will require a new language, grounded in mathematics ...

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**The Argument from Design:**

...the eighteenth-century theologian William Paley:

Just as a watch is too complicated and too functional to have sprung into existence by accident, so too must all living things, with their far greater complexity, be purposefully designed. 

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**Francisco J. Ayala**  [http://www.counterbalance.net/evolution/revo-frame.html](http://www.counterbalance.net/evolution/revo-frame.html)

... The functional design of organisms and their features would therefore seem to argue for the existence of a designer. It was **Darwin's greatest accomplishment to show that**

the directive organization of living beings can be explained as the result of a natural process, natural selection, ...

... Darwin's most significant intellectual contribution is that he **brought the origin and diversity of organisms into the realm of science.**

The Copernican Revolution consisted in a commitment to the postulate that **the universe is governed by natural laws that account for natural phenomena.**

Darwin completed the Copernican Revolution by extending that commitment to the living world.

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**The Concluding Passage from The Origin of Species**

by Charles Darwin

It is interesting contemplate an entangled bank, clothed with many plants of many kinds, with birds singing on the bushes, with various insects flitting about, and with worms crawling through the damp earth, and to reflect that **these elaborately constructed forms, so different from each other, and dependent on each other in so complex a manner, have all been produced by laws acting around us.** ...

**There is grandeur in this view of life,** with its several powers, having been originally breathed into a few forms or into one; and that, whilst this planet has gone cycling on according to the fixed law of gravity, **from so simple a beginning endless forms most beautiful and most wonderful have been, and are being, evolved.**

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**Science is valued for:**

**IF (do this) THEN (that happens), ELSE**

**Based on:**