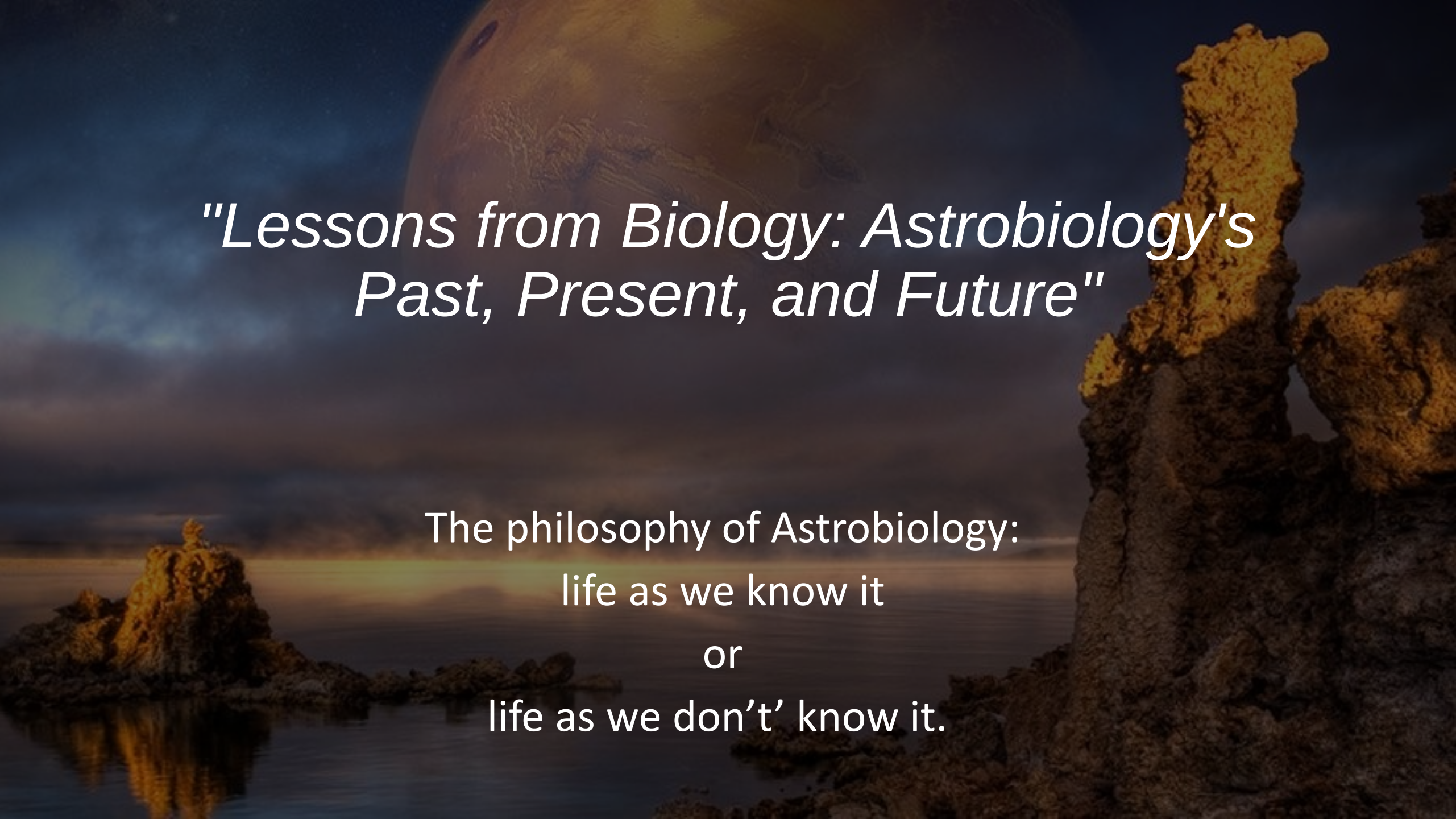
Obrigado por me deixar te ensinar em inglês.

Estou feliz por estar aqui.



"Lessons from Biology: Astrobiology's Past, Present, and Future"

The philosophy of Astrobiology:

life as we know it

or

life as we don’t’ know it.

US Space Exploration Timeline

NASA
Important to look for life here and elsewhere.

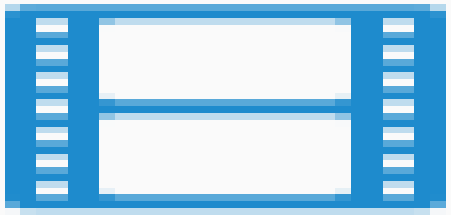
1958

Present

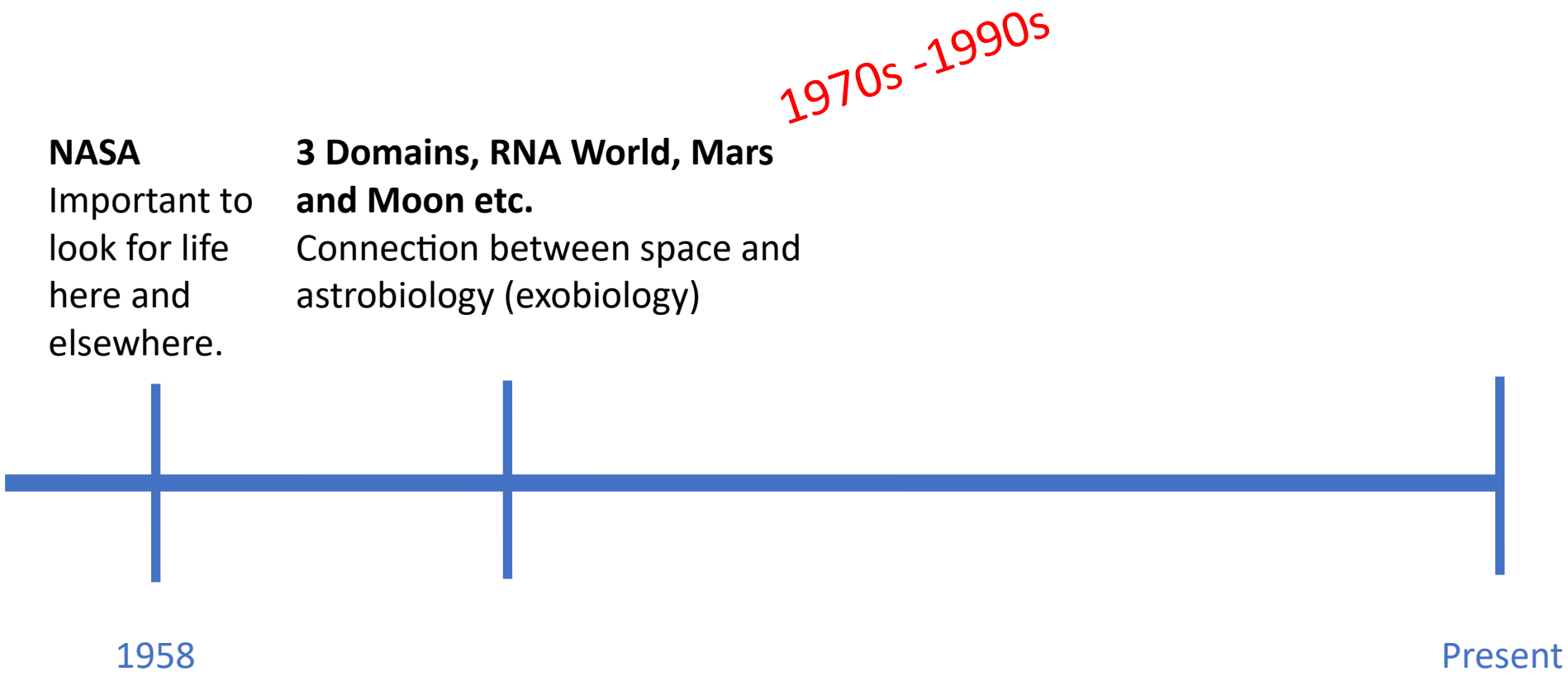
1969

Cold war with Russia

Space race

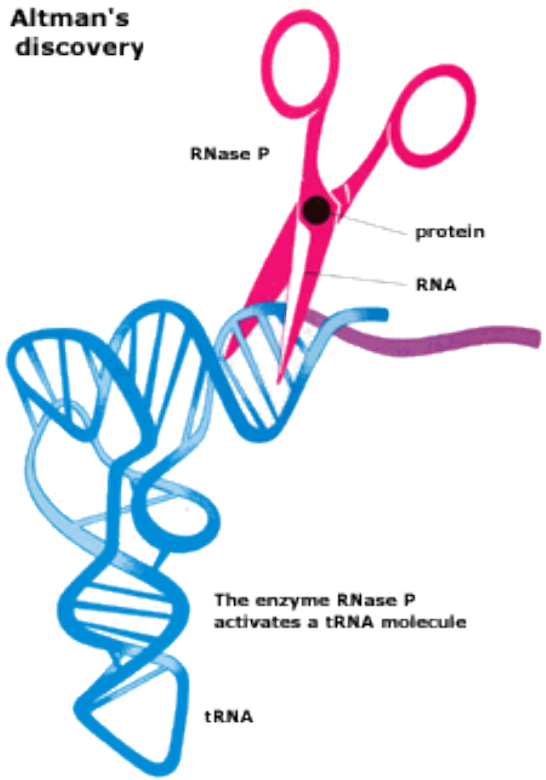


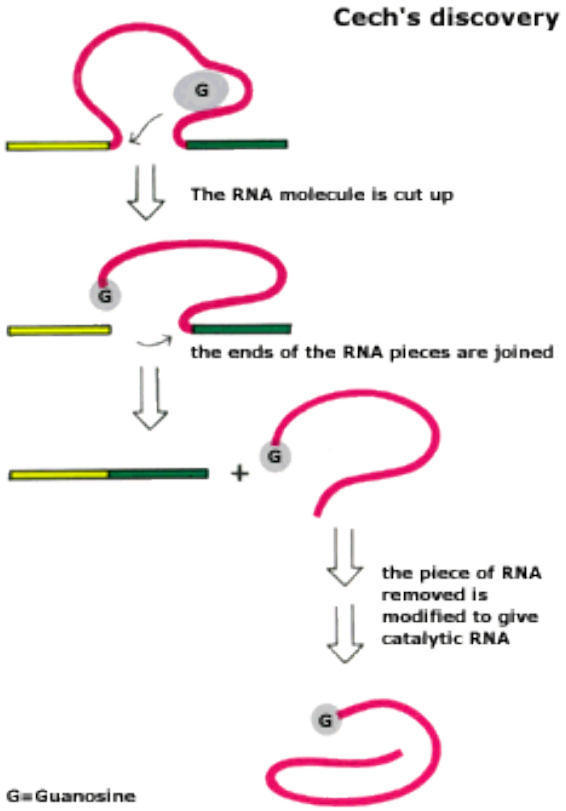
US Space Exploration Timeline



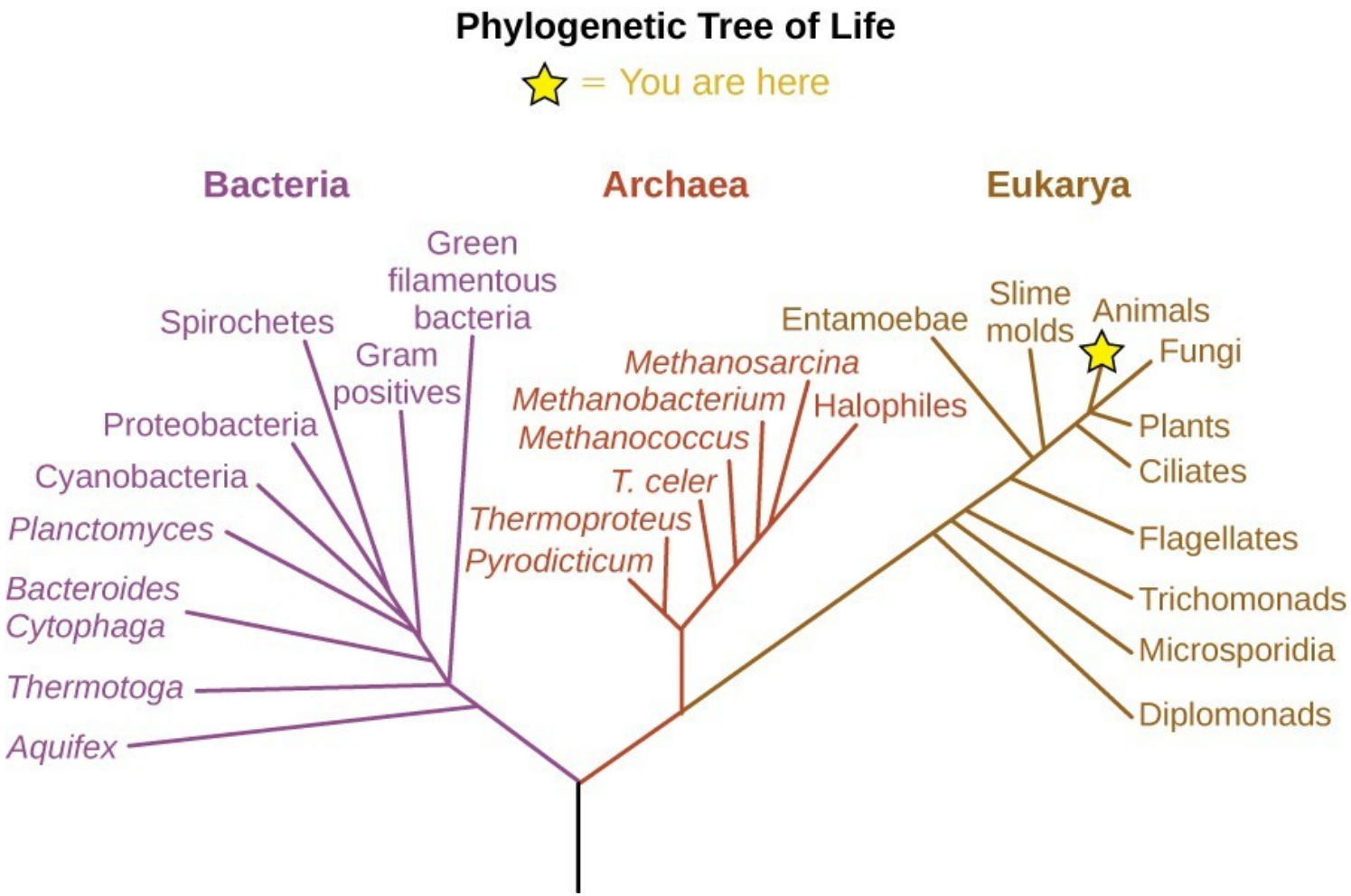
Cech and Altman, Nobel Prize

- Ribozyme

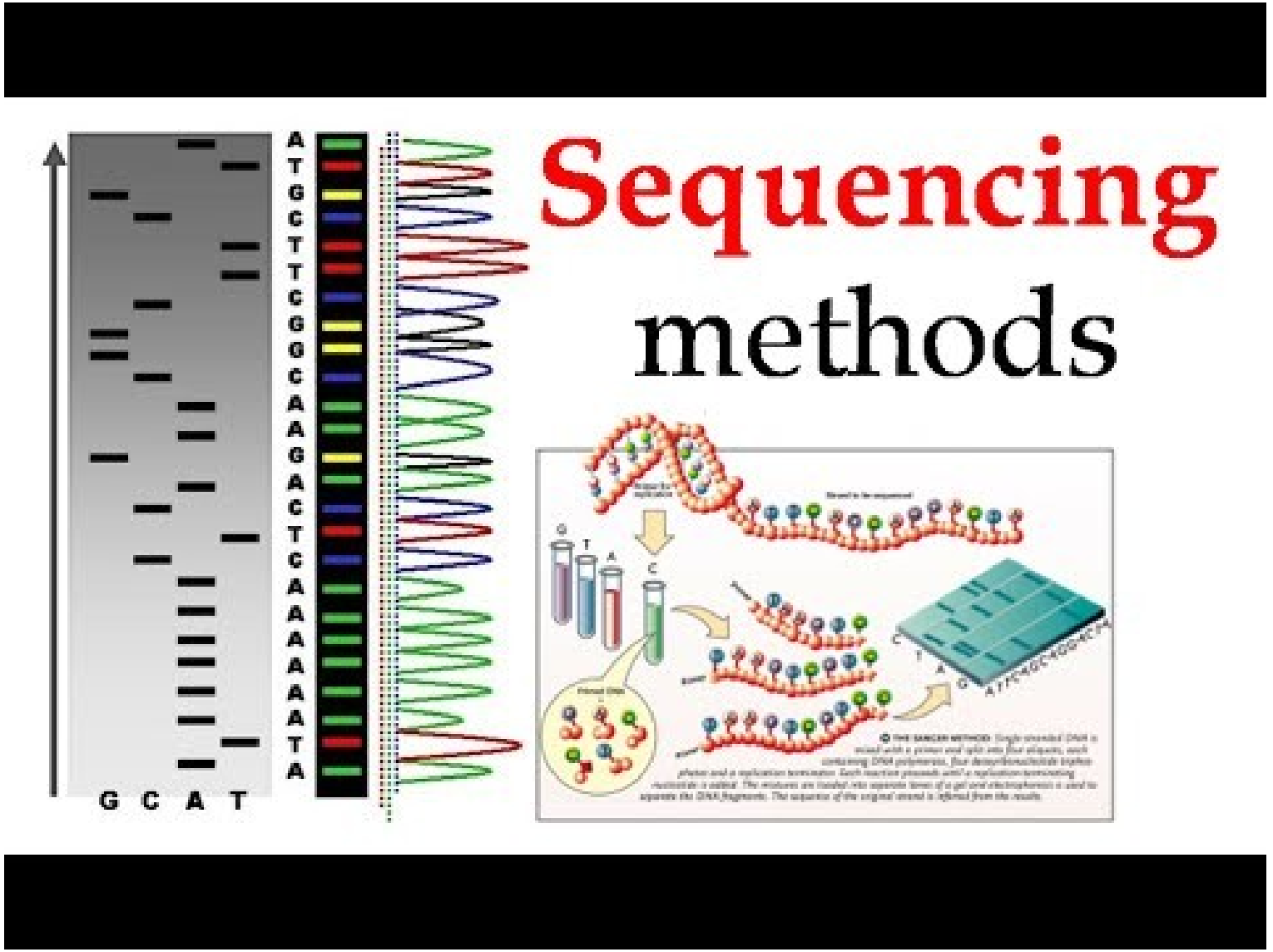




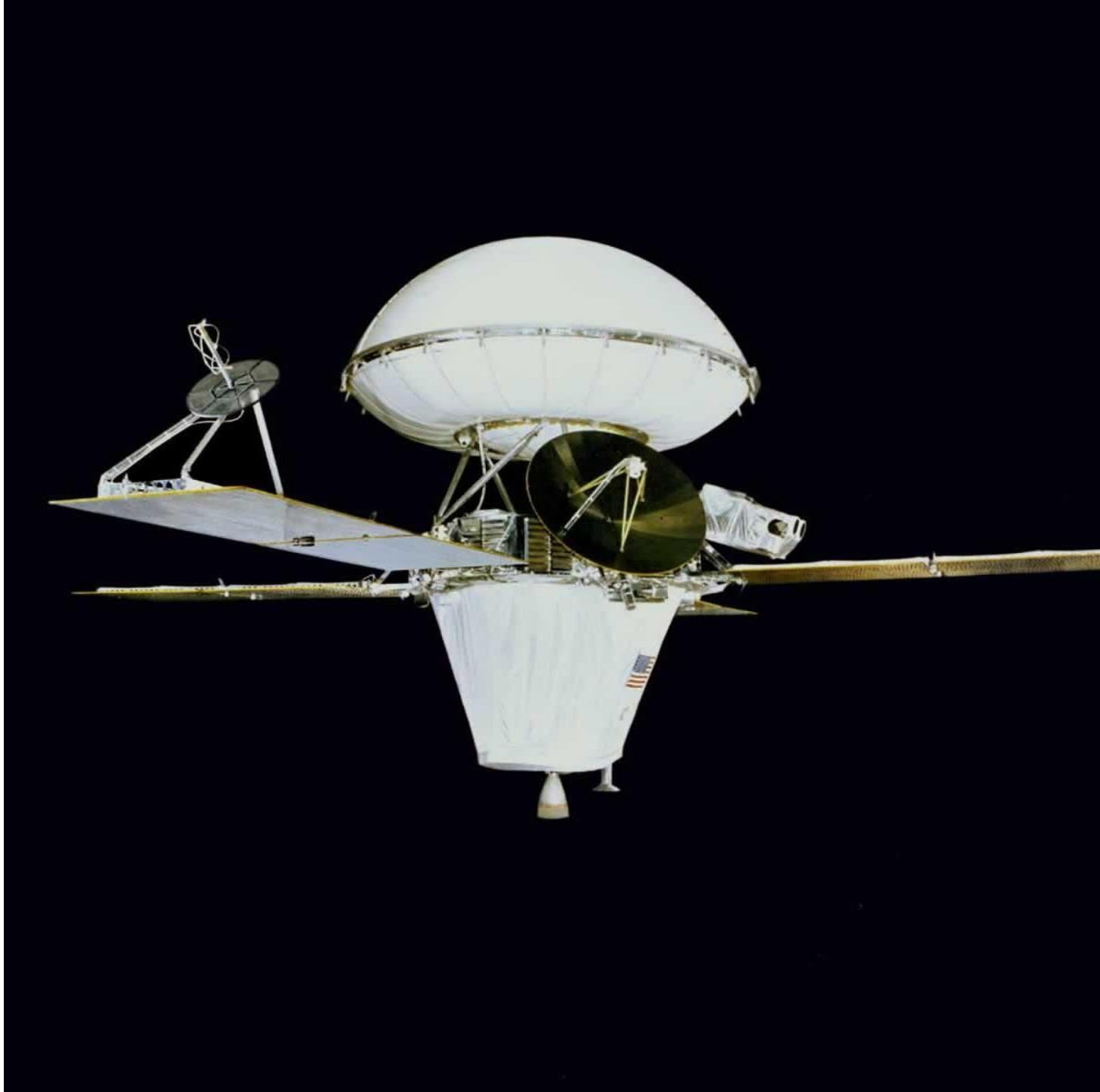
Three domains – Woese and Fox

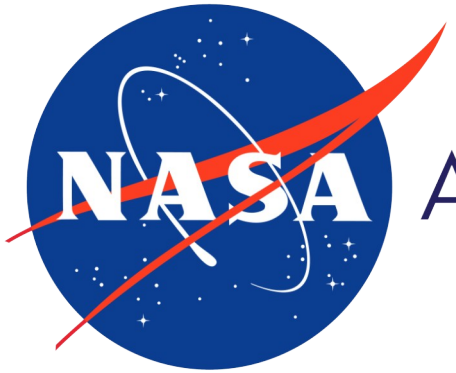


The ability to sequence DNA/RNA



Space Missions





ASTROBIOLOGY INSTITUTE

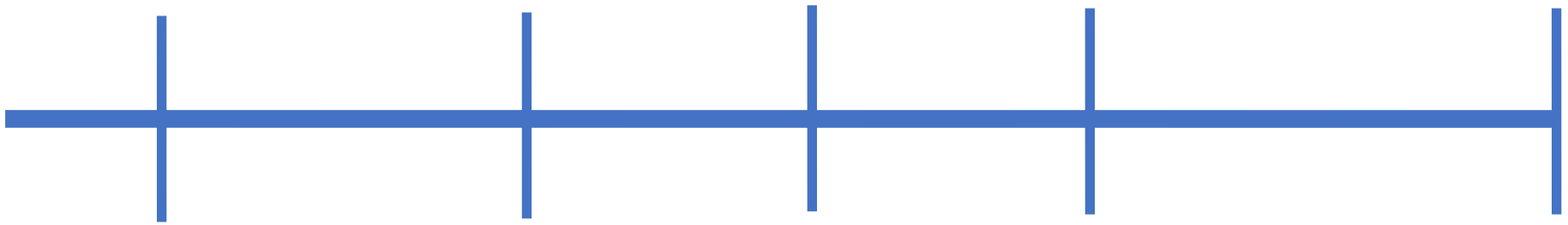
nere.

- 10 – 12 teams that included universities, NASA centers

US Space Exploration Timeline

NASA
Important to look for life here and elsewhere.

Domains, RNA World, Mars and Moon etc.
Connection between space and astrobiology (exobiology)



1958

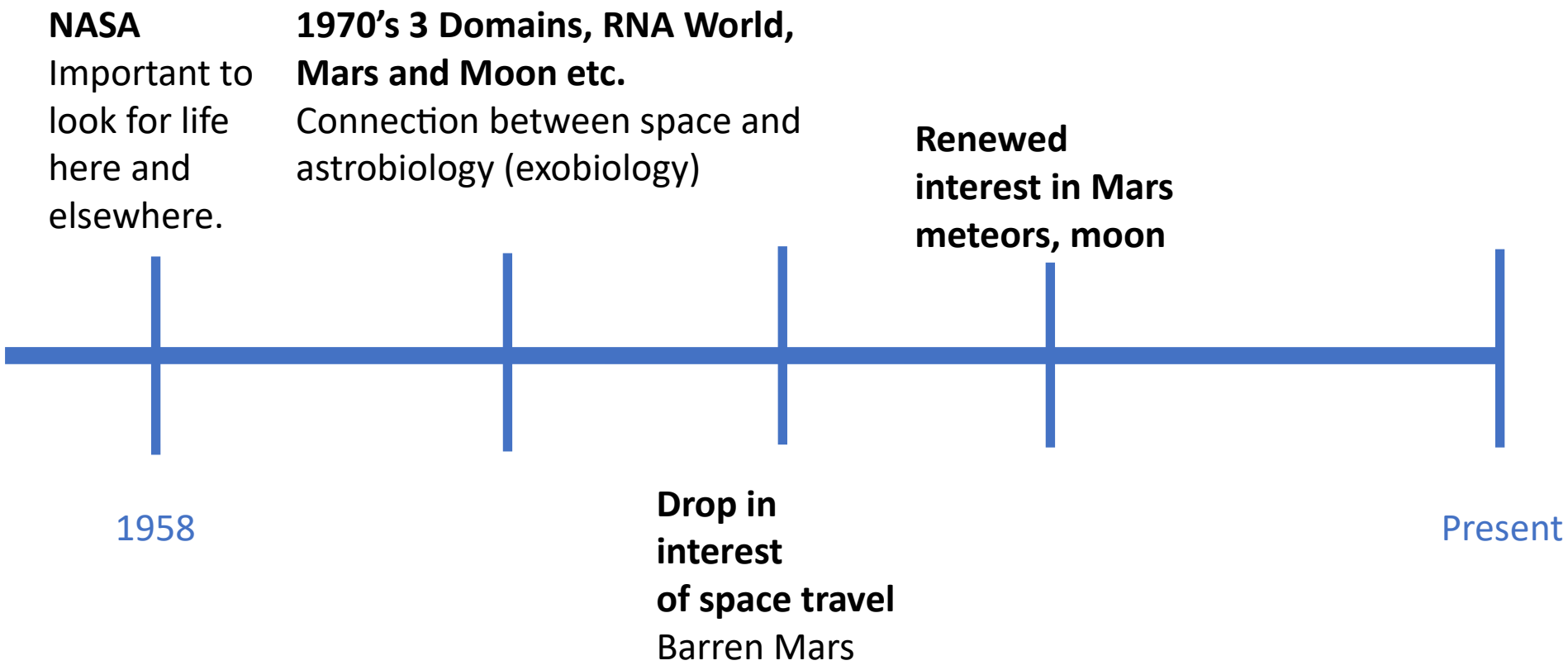
Drop in interest of space travel
Barren Mars

Present

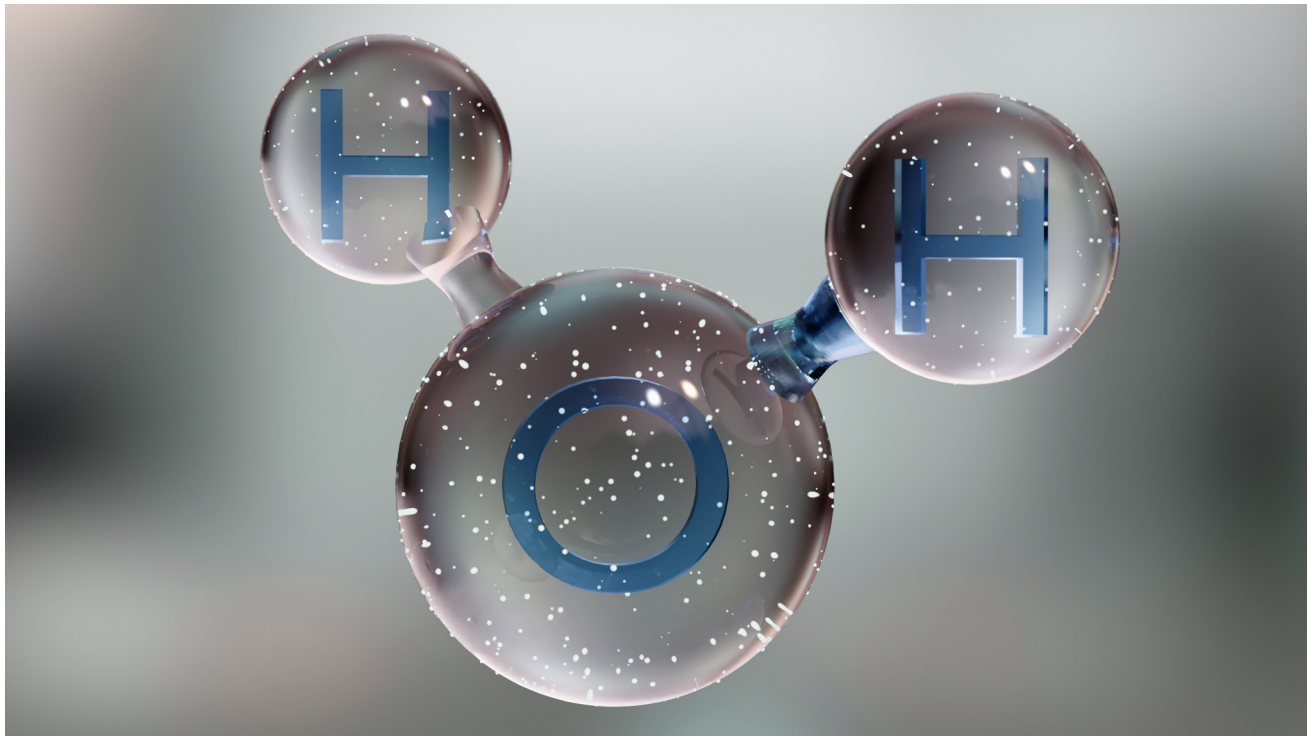
of the NAI

- Collaborations.
- Small number of colleges offered astrobiology degrees.
- Greater appreciation for wholistic strategy for understanding the evolution and life.

US Space Exploration Timeline



What factors contributed to the renewed interest?

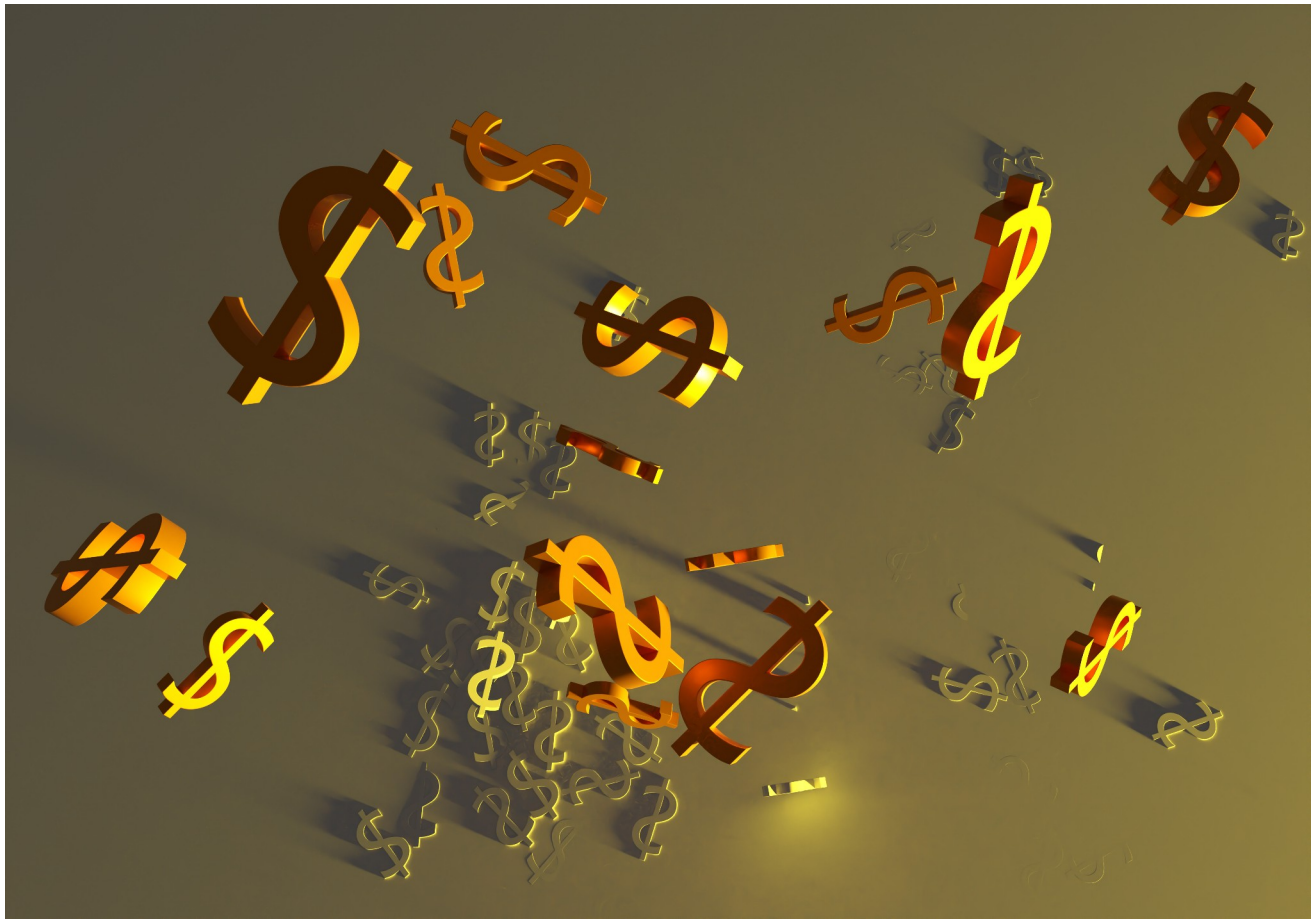


Jets spewing water vapor and ice on Saturn's moon Enceladus detected by the Cassini spacecraft in 2005.

Driving assumption!!!

Life needs liquid water

What factors contributed to the renewed interest?

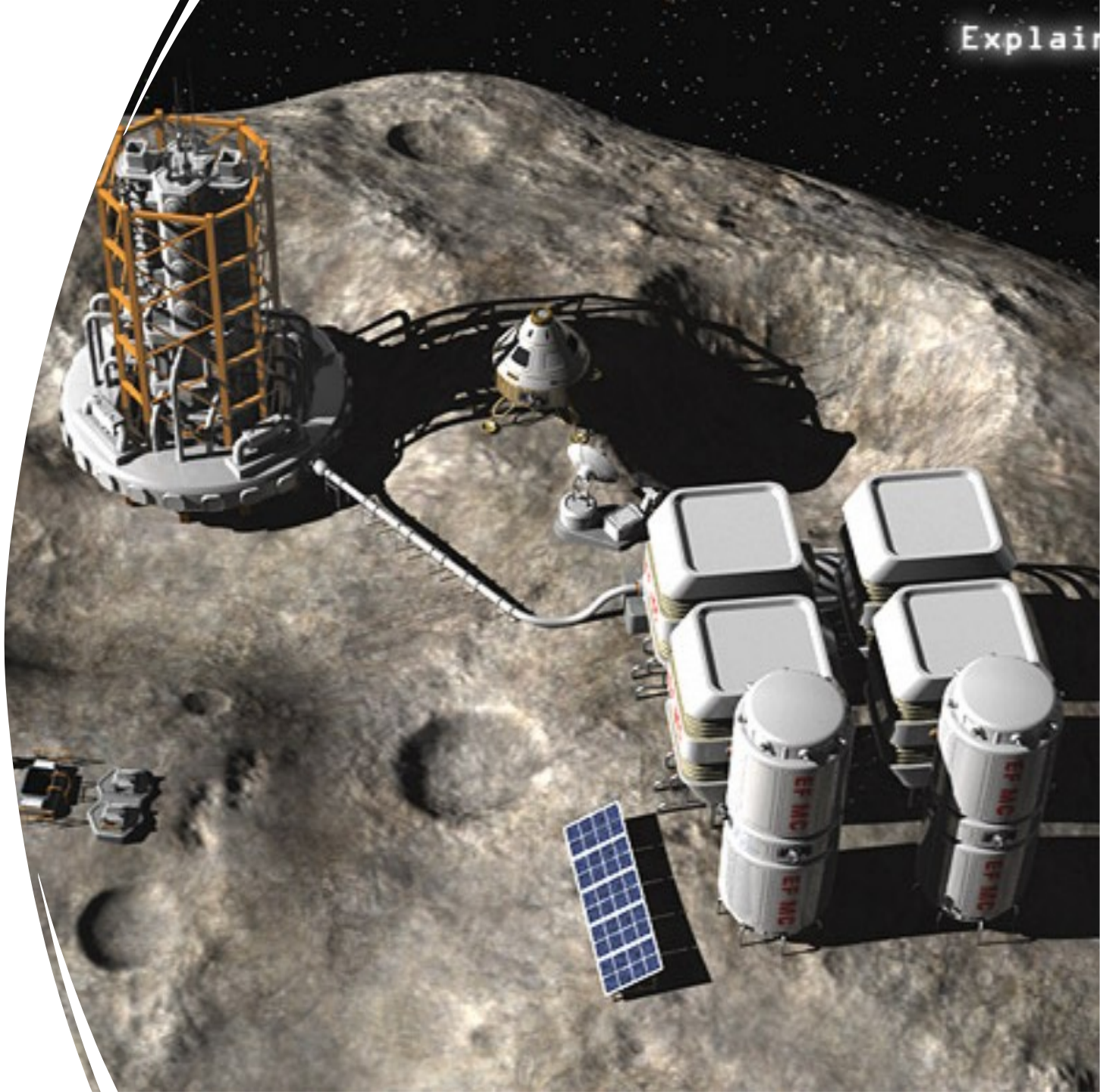


Space + Economy

- Lower costs for space travel.
- In a small metallic asteroid (1,000 meters), could provide industry metals and platinum valued at 4,500,000,000,000 USD

Space + Economy

- Larger asteroid like 16 Psych
- Contains Iron, nickel, gold, platinum
- Enough iron nickel to cover world's needs for millions of years.



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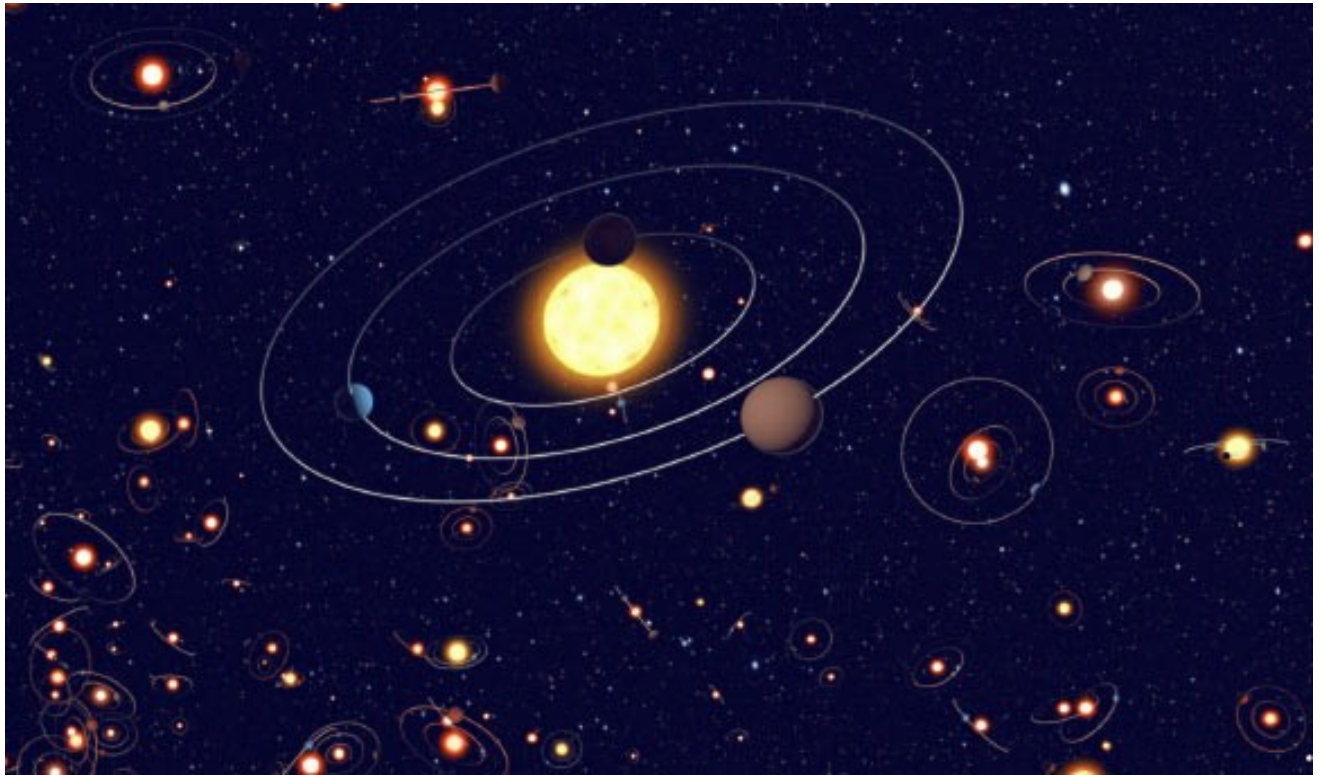
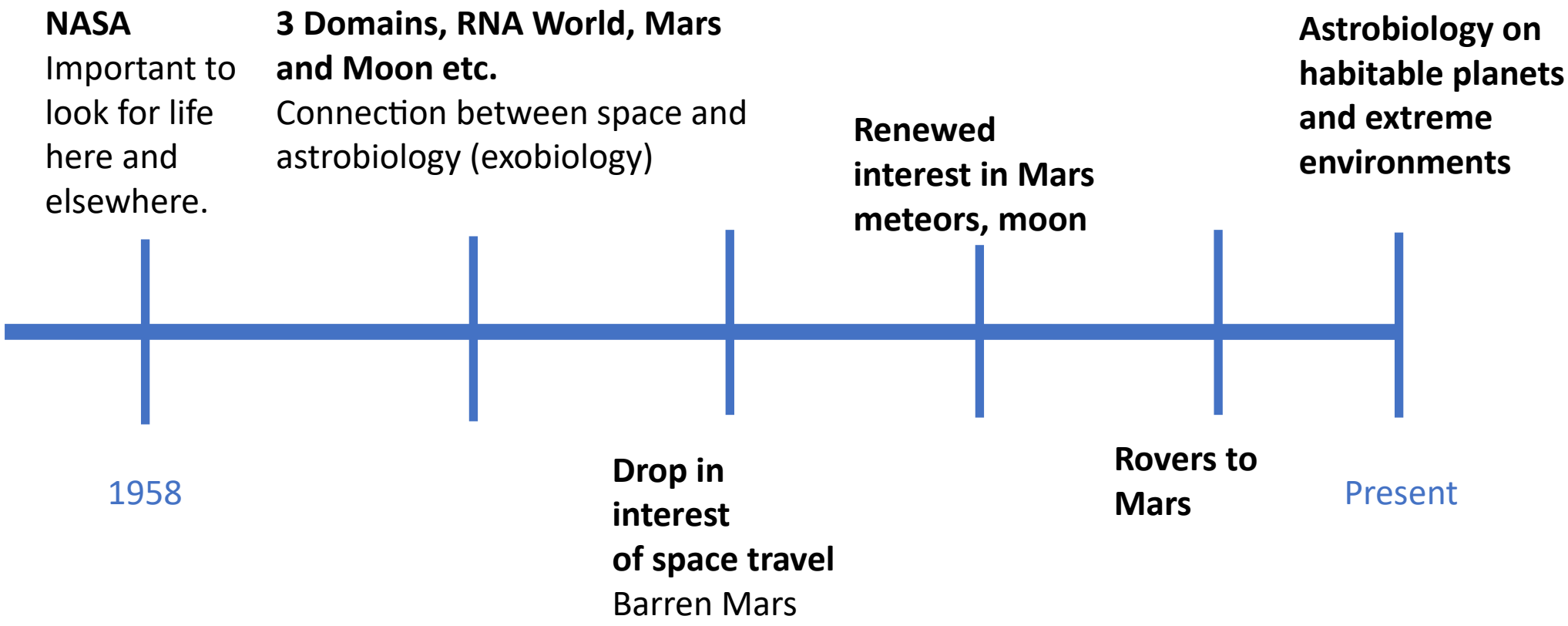


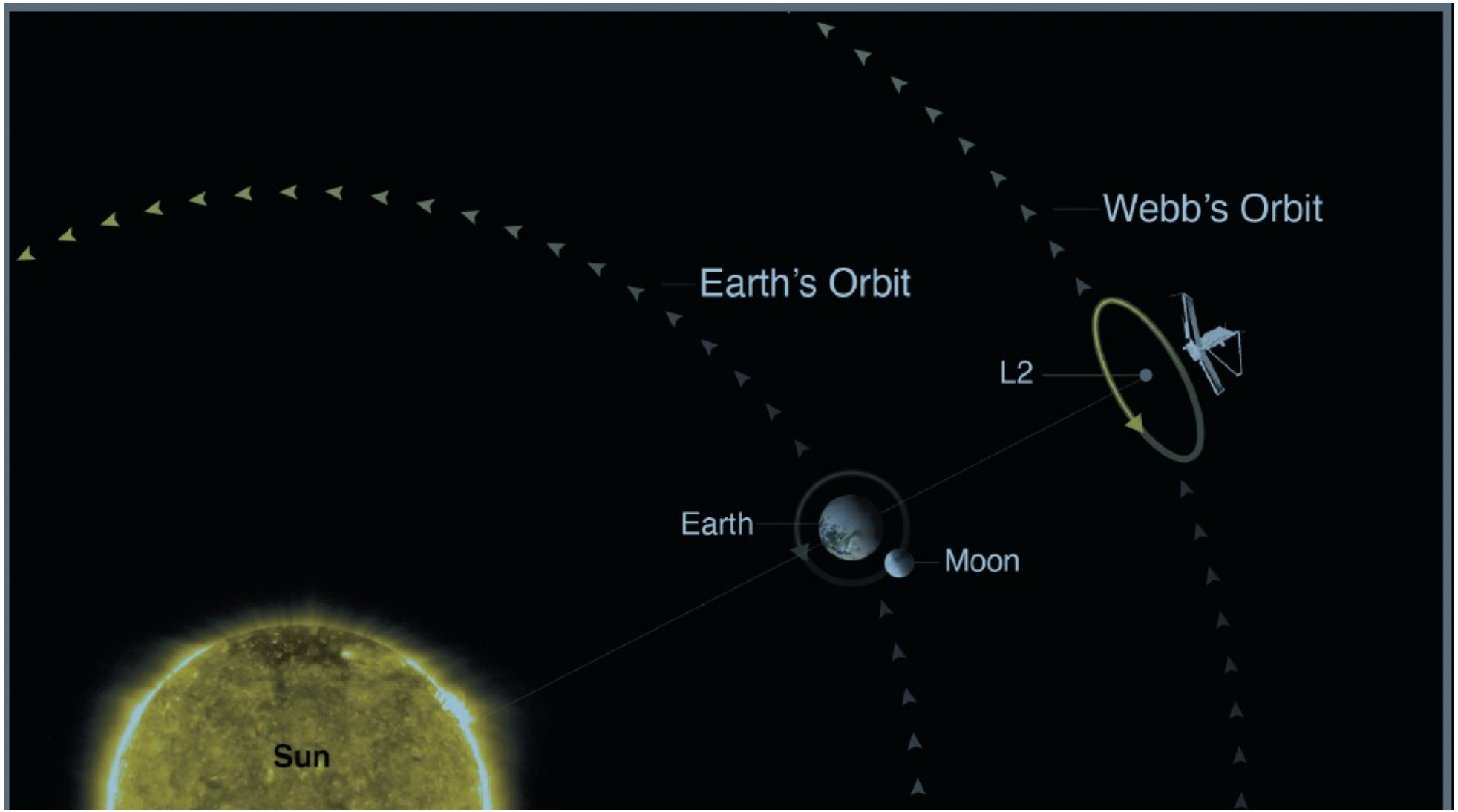
US Space Exploration Timeline



Rovers, private industry in space, International cooperation, James Webb

Rovers, private industry in space, International cooperation, James Webb

Rovers, private industry in space, International cooperation, James Webb


Webb's Orbit
Earth's Orbit
L2
Earth
Moon
Sun

Competition

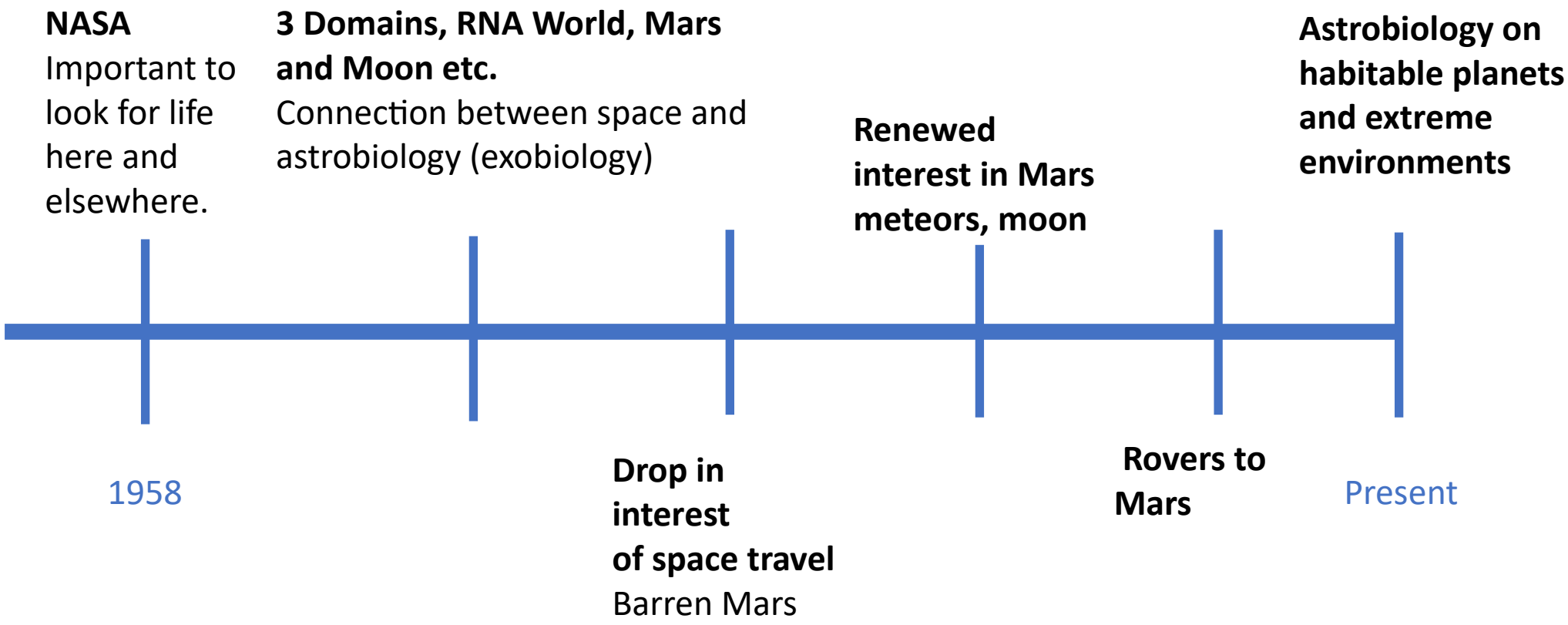
China

- Chang'e-n International Lunar Research Station (ILRS) project with Russia.
- Development of a Mars sample return mission and a Jupiter probe for launches around 2028 and 2030.
- In human spaceflight, construction of its three-module space station by the end of 2022.

India

- Still sending lots of satellites
- Historic first spacefarers to orbit, 2021
- Chandrayaan-3, a rover on the moon in 2022.

US Space Exploration Timeline



‘

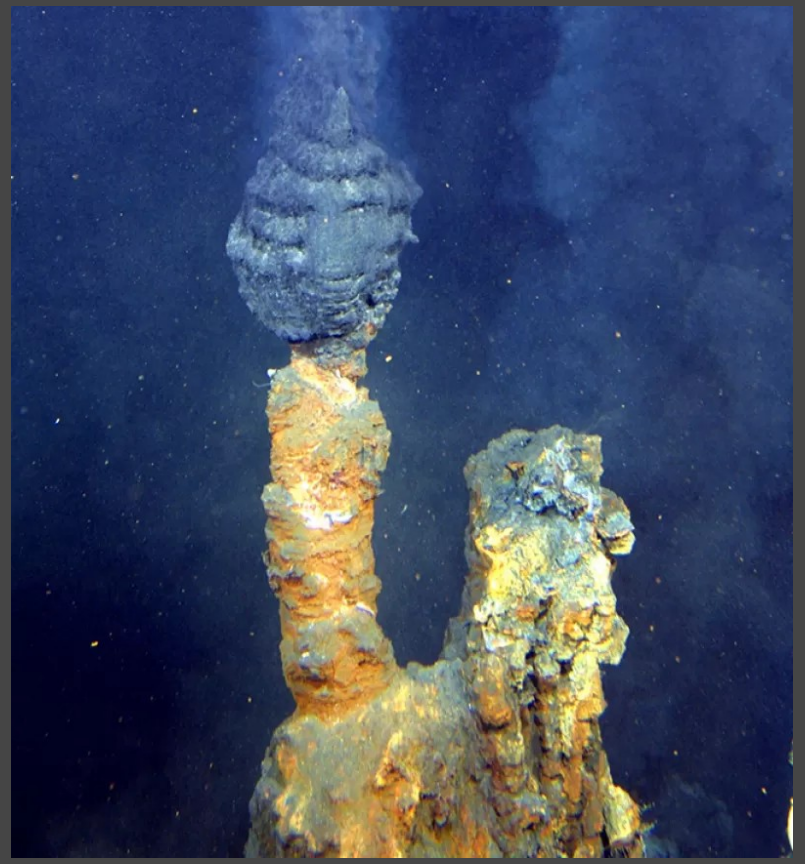
More telescopes in space (detection of habitable worlds).

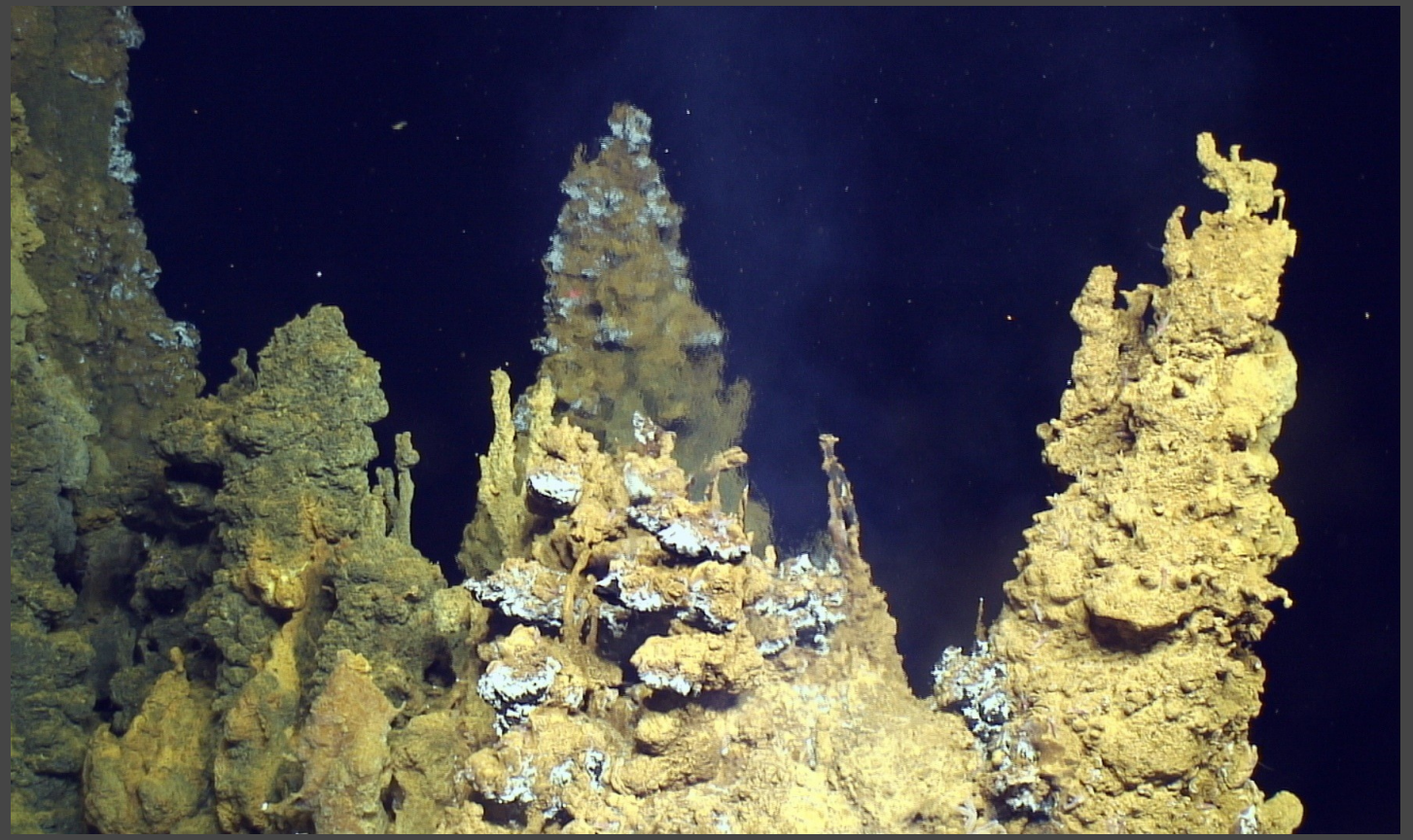
Charlie is handling the habitable planet issue so let’s discuss “extremophiles”

- The resilience of life on our planet was informative!

Acid mine drain-age

Iron Oxidiz-ers





Black smokers

- The role of plate tectonics and ocean in ecosystems

Stromatolites

- Shark Bay

For the astroBIOLOGIST

- This meant a good definition of LIFE.

- (This is the difference in the way a cosmologist experiments and a biologist experiments.)

All extant life has the following:

- DNA/RNA/Protein system of information
- Some kind of container (even viruses)

Original Articles

Vocabulary of Definitions of Life Suggests a Definition

Edward N. Trifonov

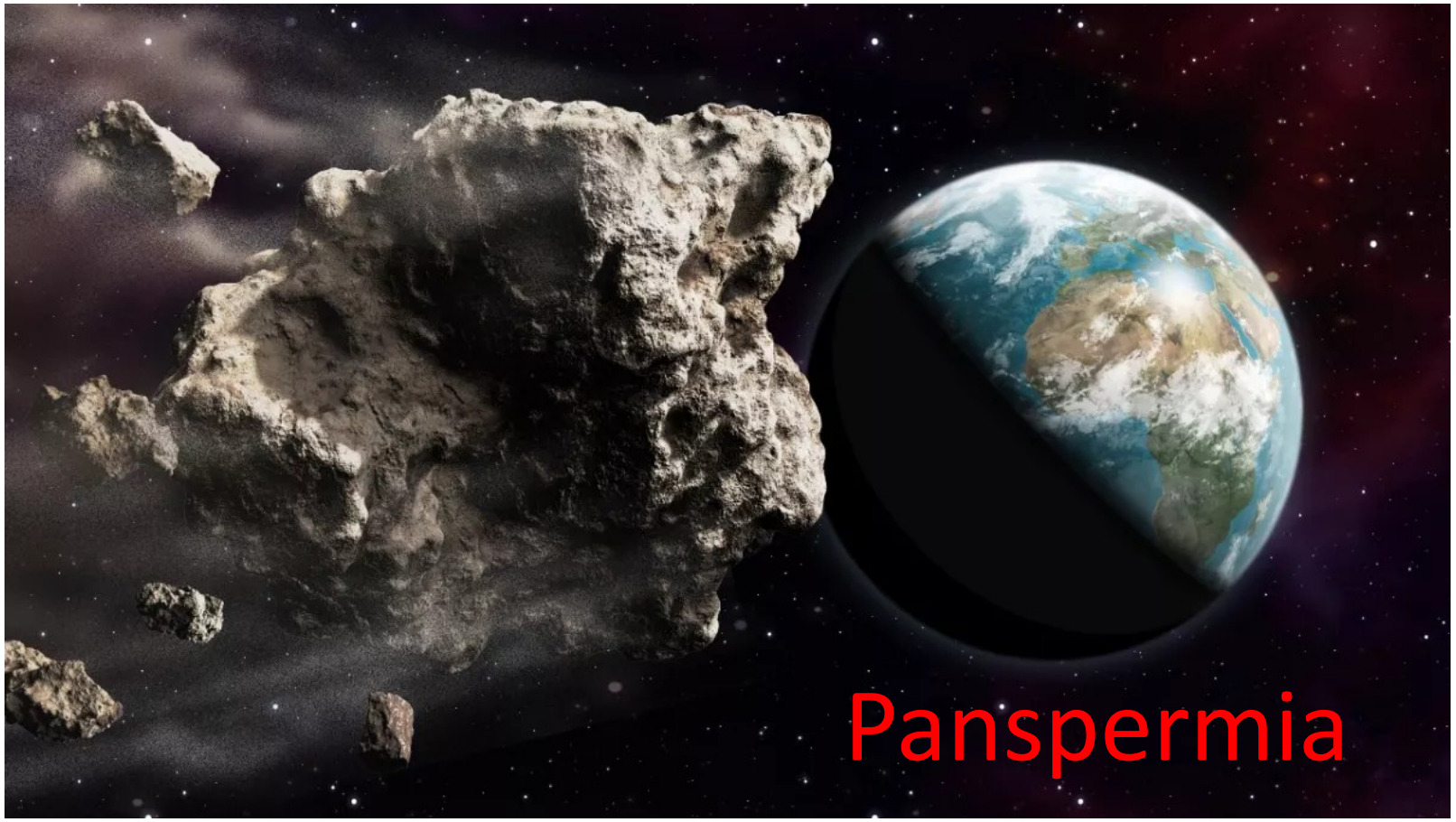
Pages 259-266 | Received 17 Mar 2011, Publishe

- J
  ournal of Biomole
  cular Structure a
  nd Dynamics
  , suggesting uncovering 123 different published definitions.

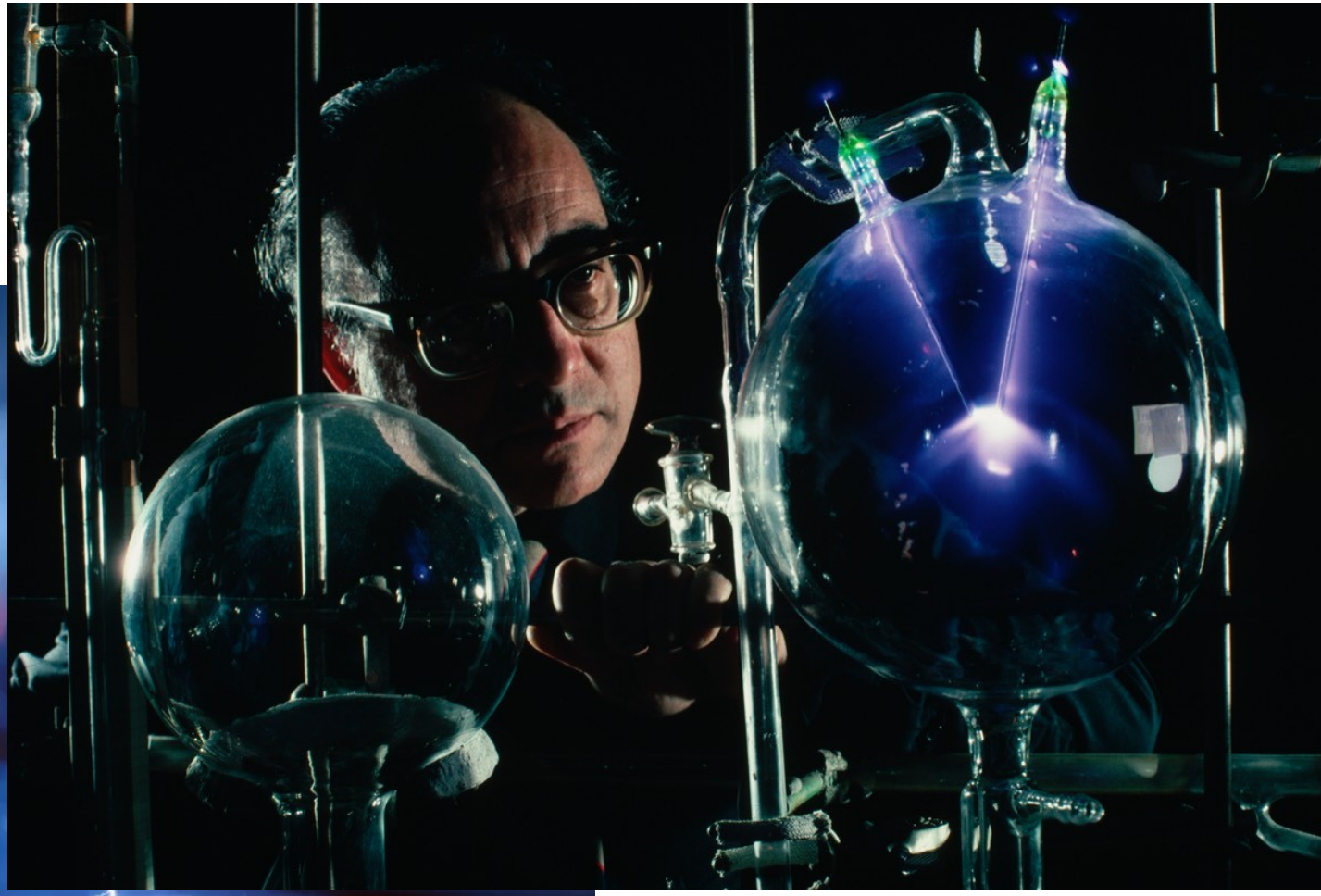
Life is self-reproduction with variations.

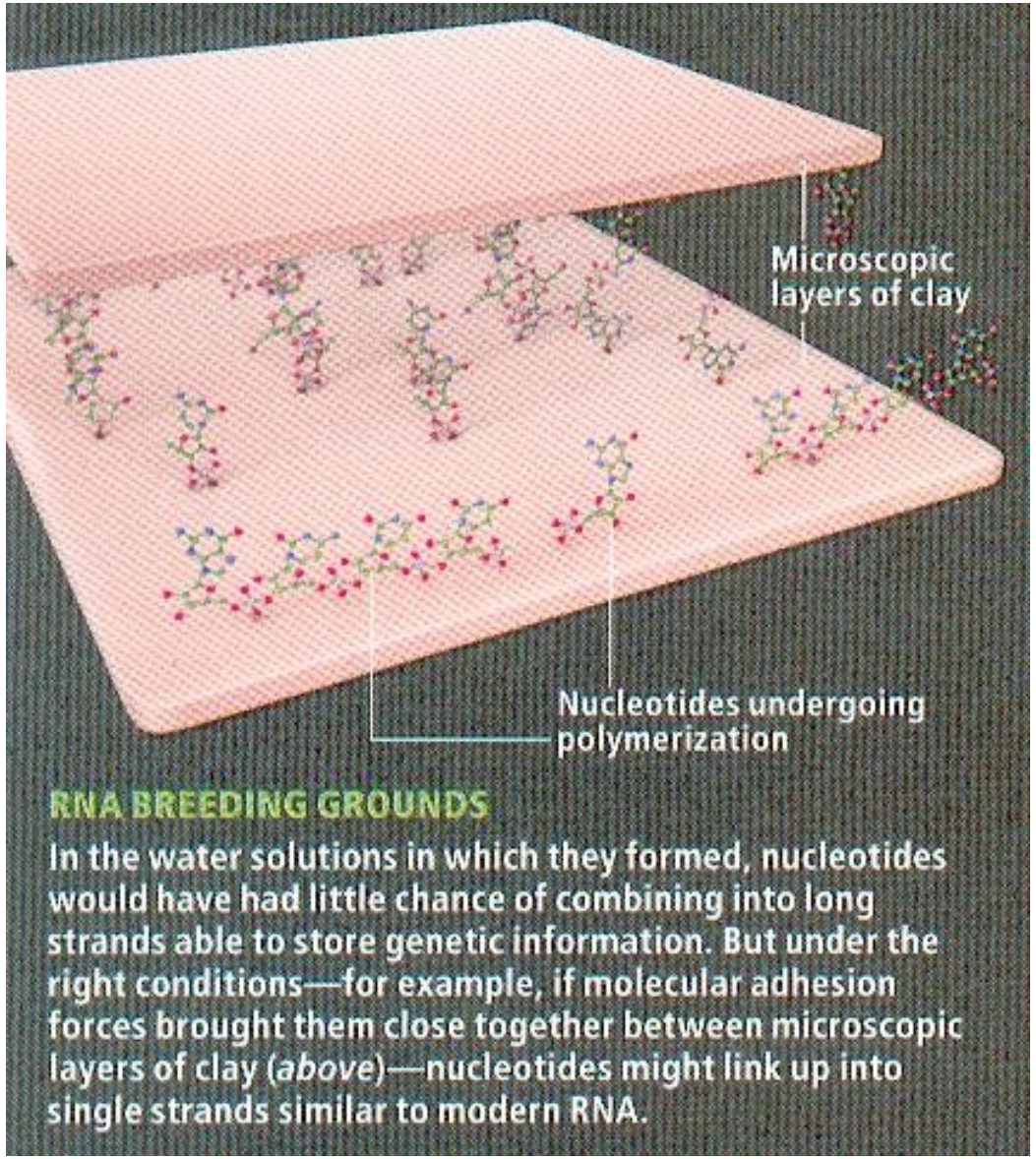
process	15	Sum	40
metabolism	14	**ABILITY**	12
processes	8	able	11
reactions	5	capable	11
other related words	26	capacity	5
Sum	**85**	other related words	1
		Sum	**40**

Current theories on how life got started here



Miller Urey Results





Life on Clay

- clay crystals preserve their structure as they grow and stick together
- form areas exposed to different environments and trap other molecules along the way
- Can organise them into patterns much like genes do now.

Emerging life @deep sea vents

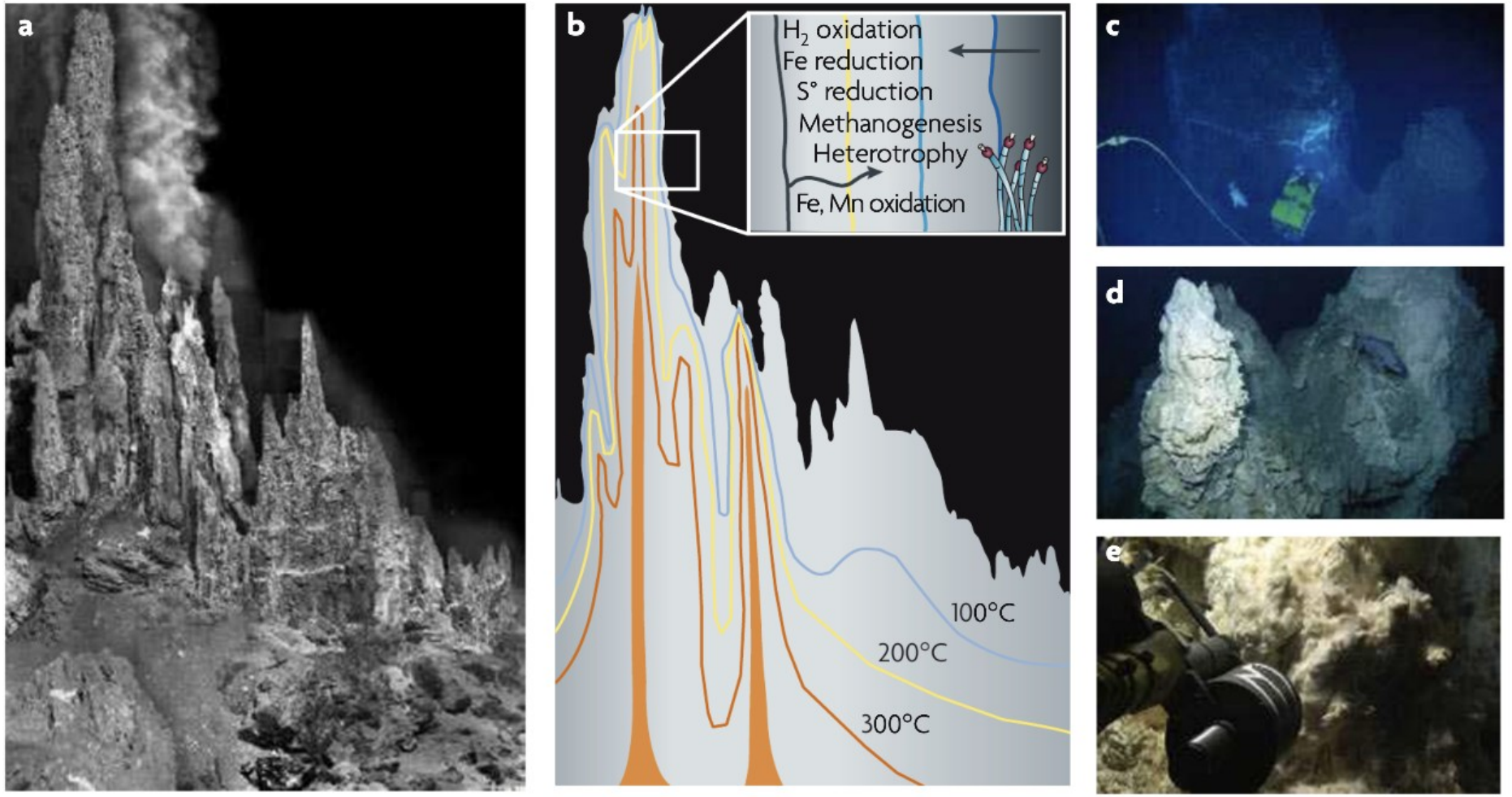


Figure 2 | **Hydrothermal vents.** There are two main types of hydrothermal vent: the black smoker type (**a,b**) and the Lost City type (**c–e**). **a** | A black smoker in the Faulty Towers complex in the Mothra hydrothermal field on the Endeavour Segment of the Juan de Fuca Ridge. The tallest chimney rises 22 metres above the sea-floor. The 'furry' appearance of the chimneys reflects the fact that the chimney walls are encrusted in dense communities of tube worms, scale worms, palm worms,

Life starts in ice…

› Icarus. 2000 Jun;145(2):609-13. doi: 10.1006/icar.2000.6365.

Prebiotic synthesis of adenine and amino acids under Europa-like conditions

M Levy [1], S L Miller, K Brinton, J L Bada

Collaborators, Affiliations + expand

PMID: 11543508 DOI: 10.1006/icar.2000.6365

Metabolism first

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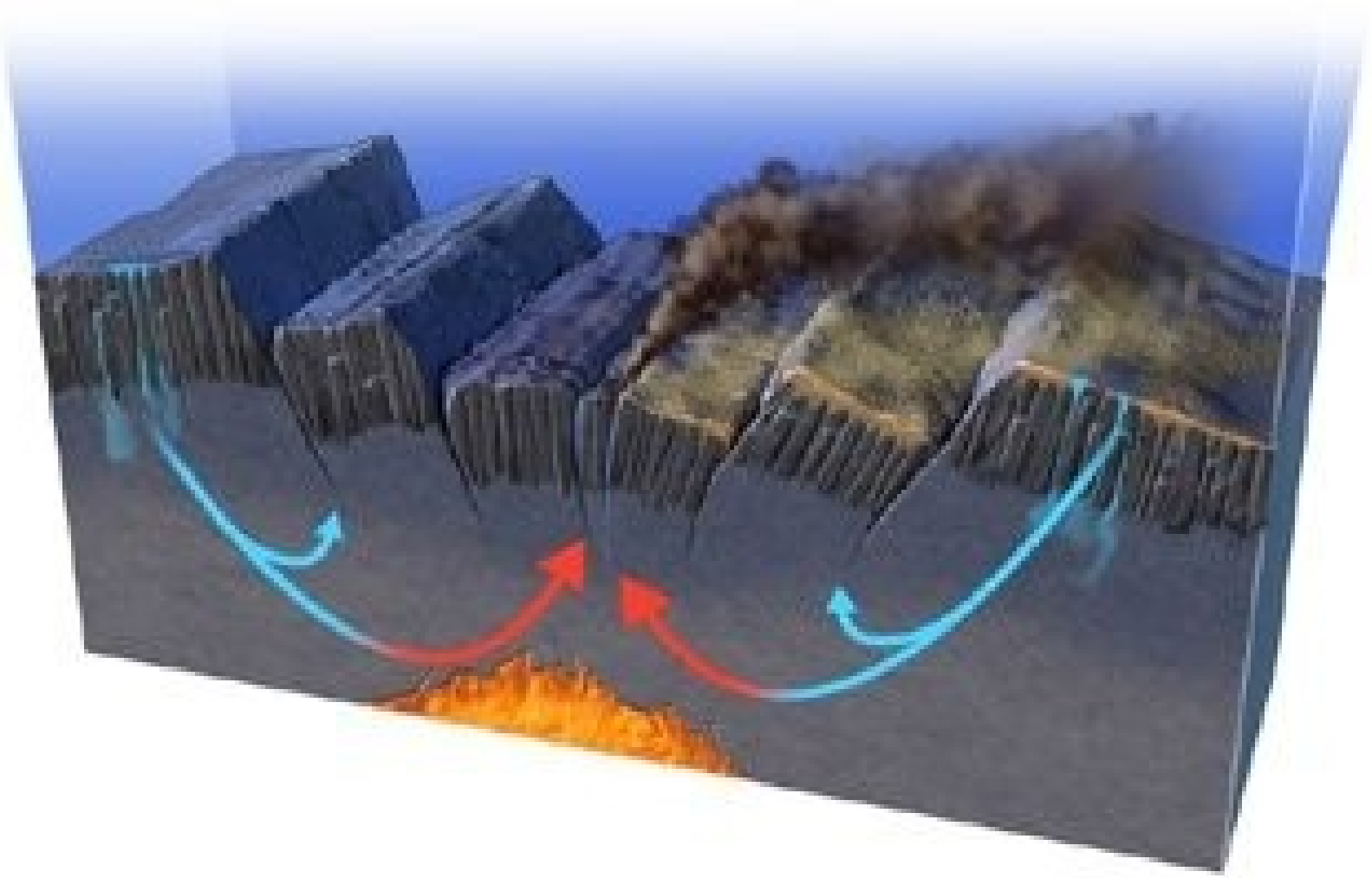

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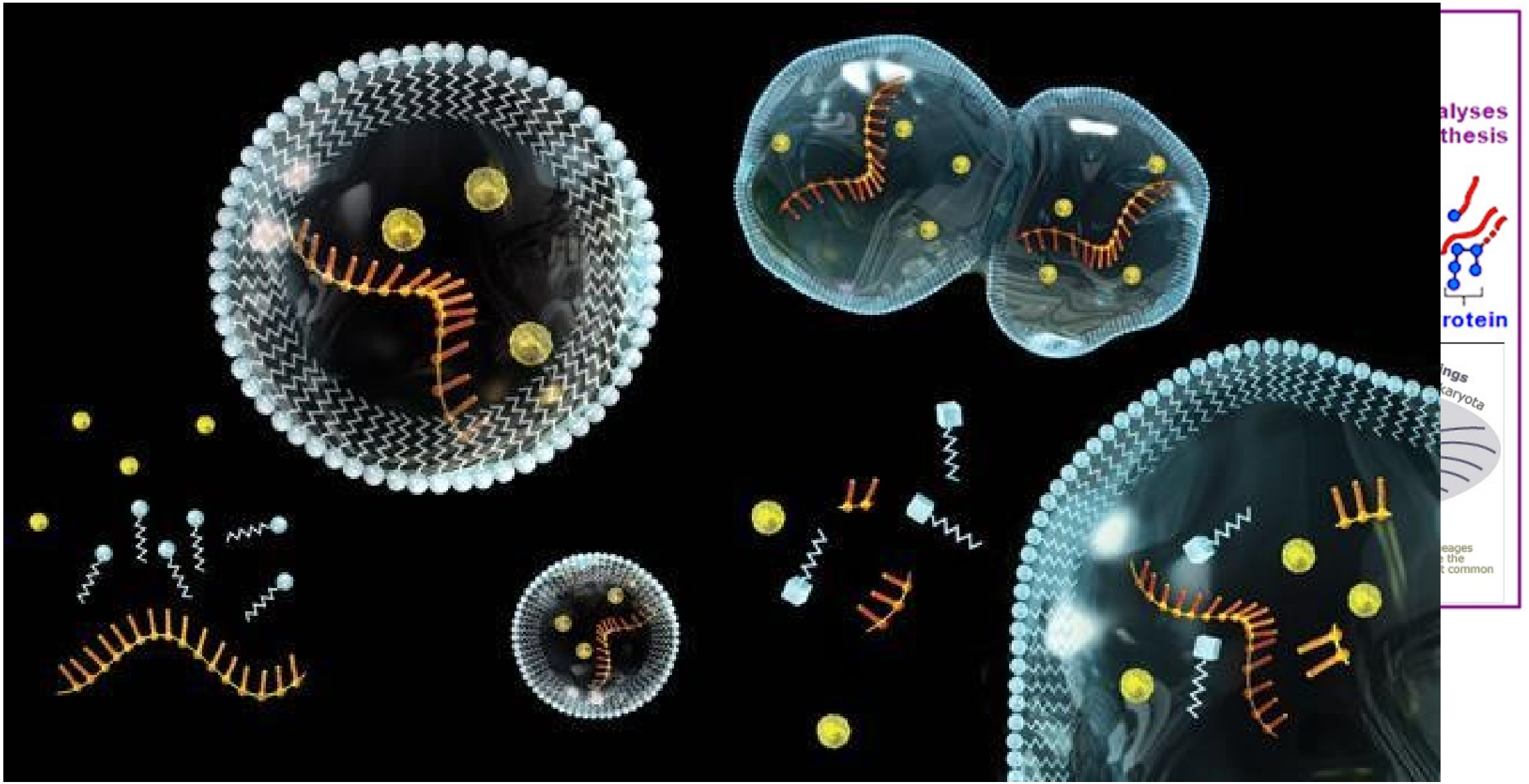
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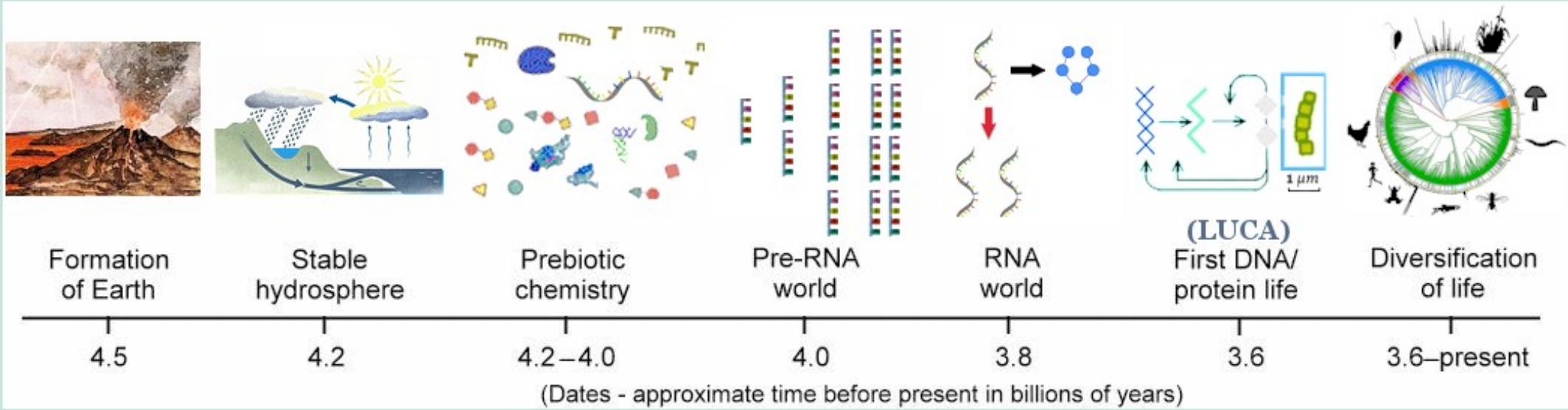
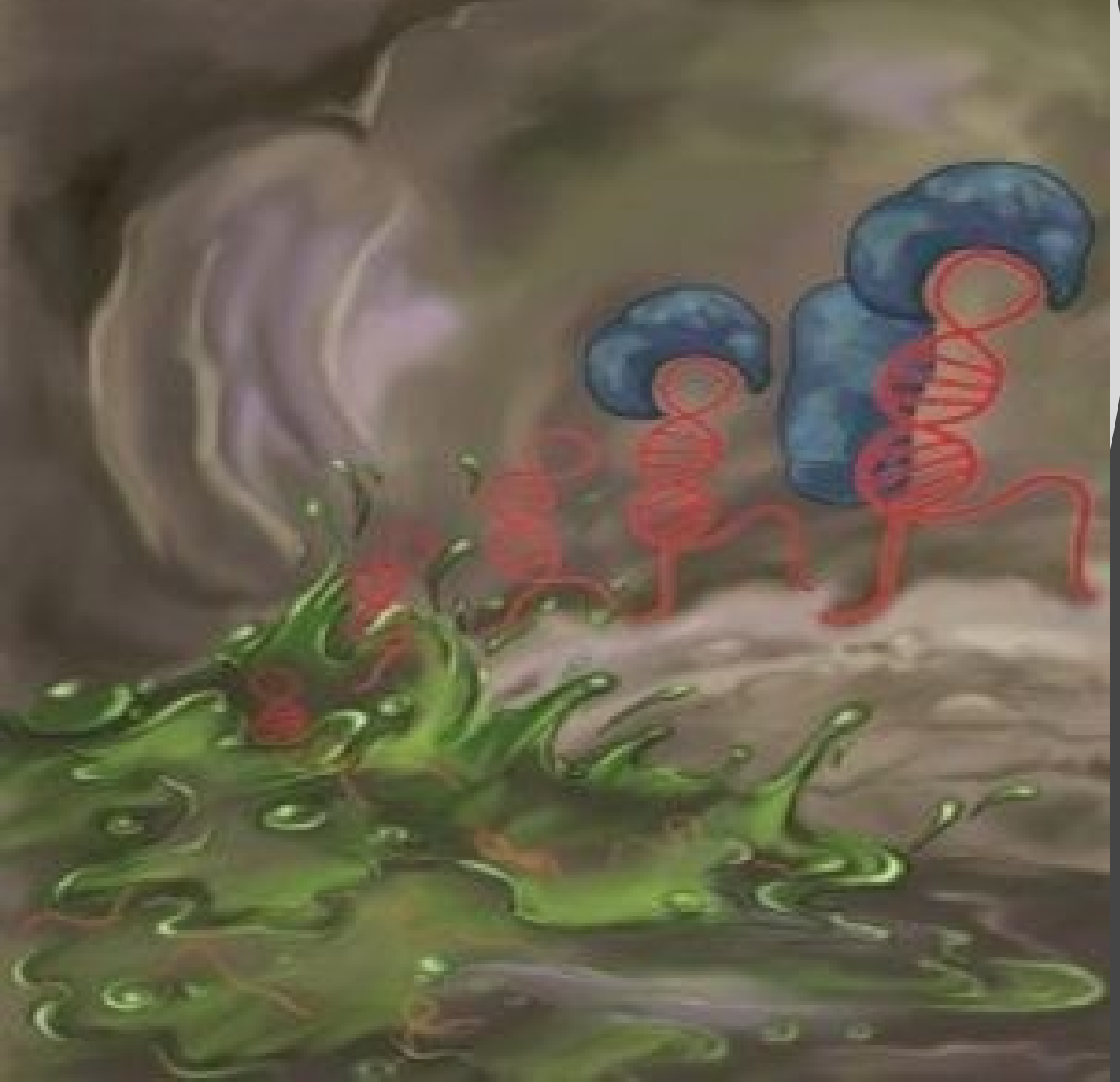
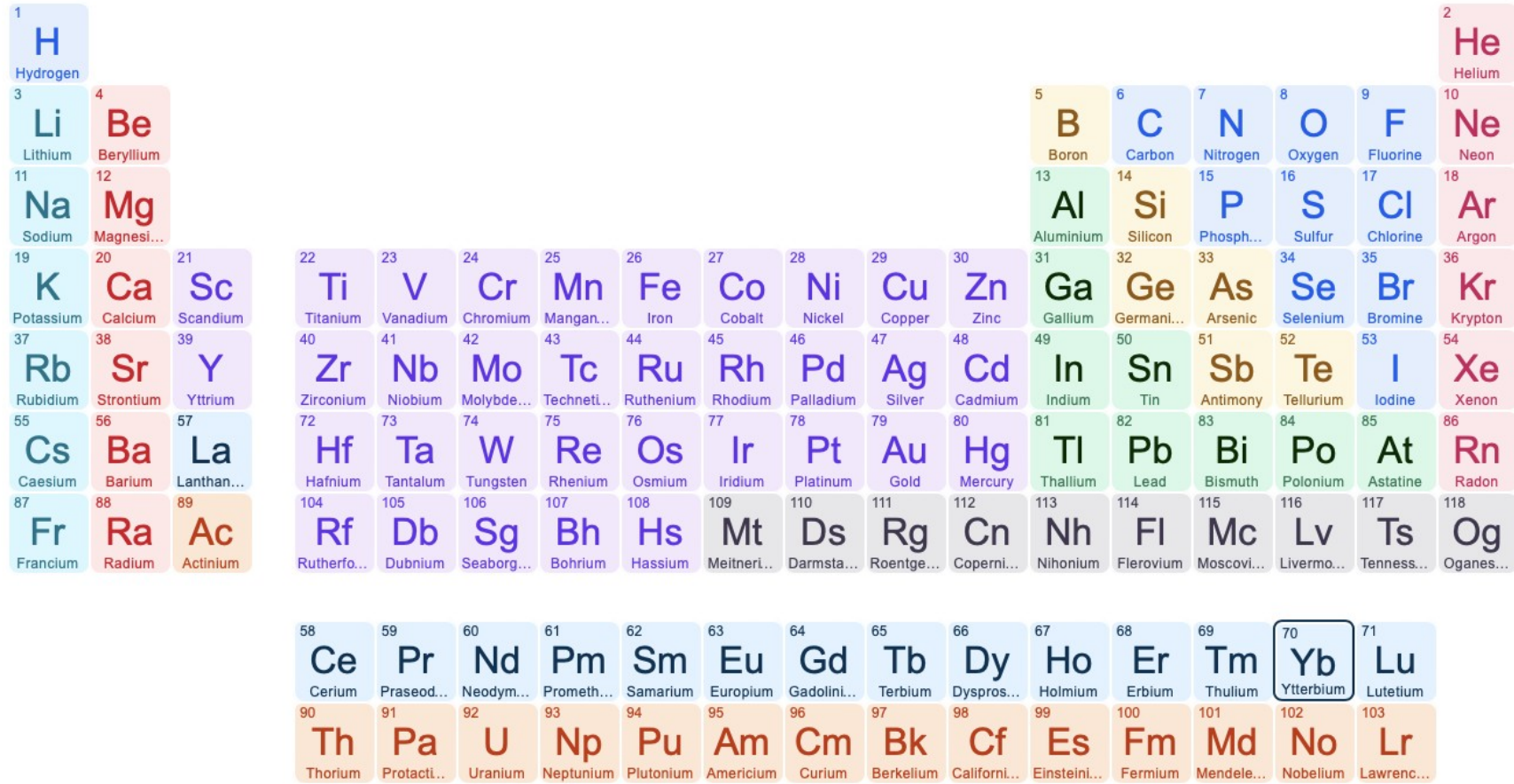


Timeline of events pertaining to the early history of life on Earth.



RNA WORLD

Periodic Table



- Alkali metals
- Alkaline earth metals
- Transition metals
- Post-transition metals
- Metalloids
- Reactive nonmetals
- Noble gases
- Lanthanides
- Actinides
- Unknown properties

Overview of hypothetical types of biochemistry			
Type	Basis	Synopsis	Remarks
Alternative nucleic acids	Alternative biochemistry	Different genetic storage	Xeno nucleic acids (XNA) may possibly be used in place of RNA or DNA. XNA is the general term for a nucleic acid with an altered sugar backbone. Examples of XNA include TNA, which uses threose, HNA, which uses 1,5-anhydrohexitol, GNA, which uses glycol, CeNA, which uses cyclohexene, LNA, which utilizes a form of ribose that contains an extra linkage between its 4' carbon and 2' oxygen, FANA, which uses arabinose but with a single fluorine atom attached to its 2' carbon, and PNA, which uses, in place of sugar and phosphate, N-(2-aminoethyl)-glycine units connected by peptide bonds.[8] In comparison, Hachimoji DNA changes the base pairs instead of the backbone. These new base pairs are P (2-Aminoimidazo[1,2a][1,3,5]triazin-4(1H)-one), Z (6-Amino-5-nitropyridin-2-one), B (Isoguanine), and S (rS = Isocytosinefor RNA, dS = 1-Methylcytosine for DNA).[9][10]
Alternative-chiralitybiomolecules	Alternative biochemistry	Mirror image biochemistry	Perhaps the least unusual alternative biochemistry would be one with differing chirality of its biomolecules. In known Earth-based life, amino acids are almost universally of the L form and sugars are of the D form. Molecules using D amino acids or L sugars are possible, though would be incompatible with organisms using the opposing chirality molecules. Gram-positive bacteria incorporate D Alanine into their Peptidoglycan layer, created through the actions of Racemases[4]
Ammonia biochemistry	Non-water solvents	Ammonia-based life	Ammonia is relatively abundant in the universe and has chemical similarities to water. The possible role of liquid ammonia as an alternative solvent for life is an idea that goes back at least to 1954, when J. B. S. Haldane raised the topic at a symposium about life's origin.
Arsenic biochemistry	Alternative biochemistry	Arsenic-based life	Arsenic, which is chemically similar to phosphorus, while poisonous for most life forms on Earth, is incorporated into the biochemistry of some organisms.
Borane biochemistry (Organoboron chemistry)	Alternative biochemistry	Boranes-based life	Boranes are dangerously explosive in Earth's atmosphere, but would be more stable in a reducing environment. Boron, however, is exceedingly rare in the universe in comparison to its neighbours carbon, nitrogen, and oxygen. On the other hand, structures containing alternating boron and nitrogen atoms share some properties with hydrocarbons.
Cosmic necklace-based biology	Nonplanetary life	Non-chemical life	In 2020, Luis A. Anchordoqu and Eugene M. Chudnovsky hypothesized that life composed of magnetic semipoles connected by cosmic strings could evolve inside stars.[5]
Dusty plasma-based biology	Nonplanetary life	Non-chemical life	In 2007, Vadim N. Tsytovich and colleagues proposed that lifelike behaviors could be exhibited by dust particles suspended in a plasma, under conditions that might exist in space.[6]
Extremophiles	Alternative environment	Life in variable environments	It would be biochemically possible to sustain life in environments that are only periodically consistent with life as we know it.
Heteropoly acid biochemistry	Alternative biochemistry	Heteropoly acid-based life	Various metals can form complex structures with oxygen, such as heteropoly acids.
Hydrogen fluoridebiochemistry	Non-water solvents	Hydrogen fluoride-based life	Hydrogen fluoride has been considered as a possible solvent for life by scientists such as Peter Sneath.
Hydrogen sulfidebiochemistry	Non-water solvents	Hydrogen sulfide-based life	Hydrogen sulfide is a chemical analog of water, but is less polar and a weaker inorganic solvent.
Methane biochemistry (Azotosome)	Non-water solvents	Methane-based life	Methane (CH_4) is relatively abundant in the solar system and the universe, and is known to exist in liquid form on Titan, the largest moon of Saturn. Though highly unlikely, it is considered to probably be possible for Titan to harbour life. If so, it will most likely be Methane-based life.
Non-green photosynthesizers	Other speculations	Alternate plant life	Physicists have noted that, although photosynthesis on Earth generally involves green plants, a variety of other-colored plants could also support photosynthesis, essential for most life on Earth, and that other colors might be preferred in places that receive a different mix of stellar radiation than Earth. In particular, retinal is capable of, and has been observed to, perform photosynthesis.[7] Bacteria capable of photosynthesis are known as microbial rhodopsins. A plant or creature that uses retinal photosynthesis is always purple.
Shadow biosphere	Alternative environment	A hidden life biosphere on Earth	A shadow biosphere is a hypothetical microbial biosphere of Earth that uses radically different biochemical and molecular processes than currently known life.
Silicon biochemistry (Organosilicon)	Alternative biochemistry	Silicon-based life	Like carbon, silicon can create molecules that are sufficiently large to carry biological information; however, the scope of possible silicon chemistry is far more limited than that of carbon.
Silicon dioxidebiochemistry	Non-water solvents	Silicon dioxide-based life	Gerald Feinberg and Robert Shapiro have suggested that molten silicate rock could serve as a liquid medium for organisms with a chemistry based on silicon, oxygen, and other elements such as aluminium.
Sulfur biochemistry	Alternative biochemistry	Sulfur-based life	

Overview of hypothetical types of biochemistry	
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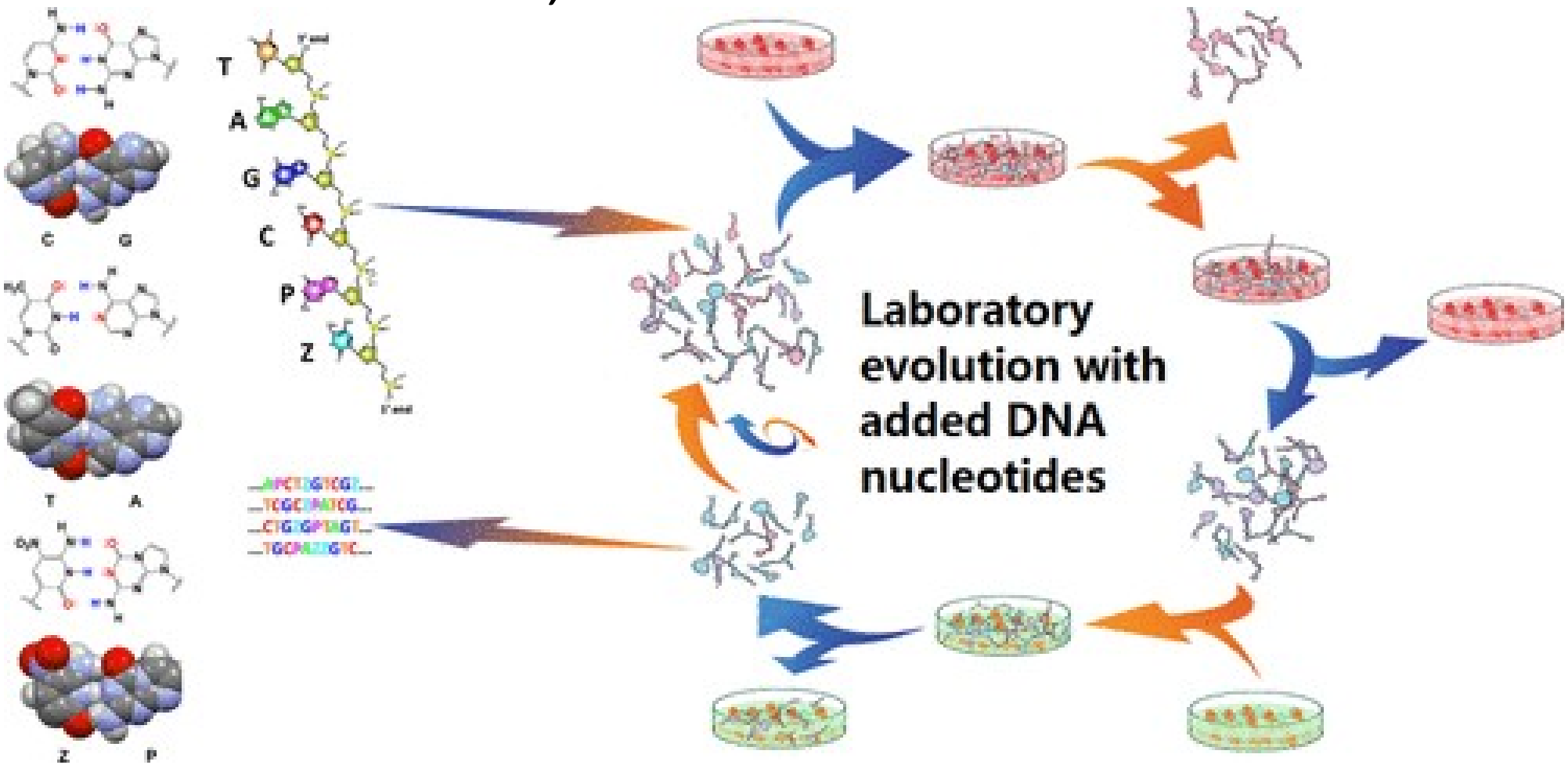
Arsenic biochemistry	Alternative biochemistry
Borane biochemistry (Organoboron chemistry)	Alternative biochemistry
Cosmic necklace-based biology	Nonplanetary life
Dusty plasma-based biology	Nonplanetary life
Extremophiles	Alternative environment
Heteropoly acid biochemistry	Alternative biochemistry
Hydrogen fluoridebiochemistry	Non-water solvents
Hydrogen sulfidebiochemistry	Non-water solvents
Methane biochemistry (Azotosome)	Non-water solvents
Non-green photosynthesizers	Other speculations
Shadow biosphere	Alternative environment
Silicon biochemistry (Organosilicon)	Alternative biochemistry
Silicon dioxidebiochemistry	Non-water solvents
Sulfur biochemistry	Alternative biochemistry

Steven Benner, Weird Life



Lessons from Biology: Astrobiology's Past, Present,and Future"

The biology in Astrobiology : bottom up and top down

THE ORIGIN OF LIFE