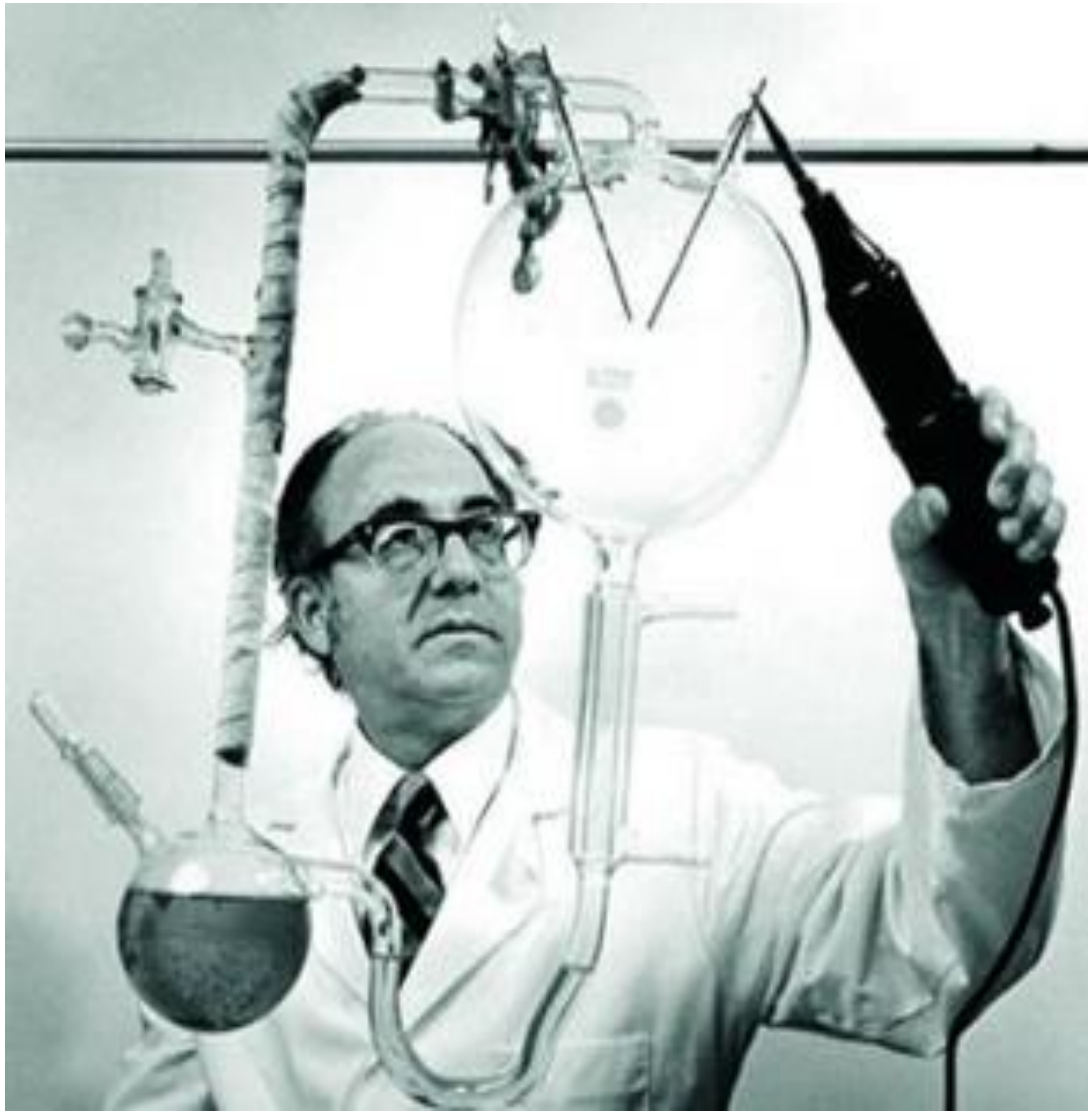
Chemical origins of life

Miller–Urey, 1953

Stanley L. Miller

Harold C. Urey

Test for the occurrence of chemical origins of life by simulating the conditions thought at the time to be present on the early Earth.



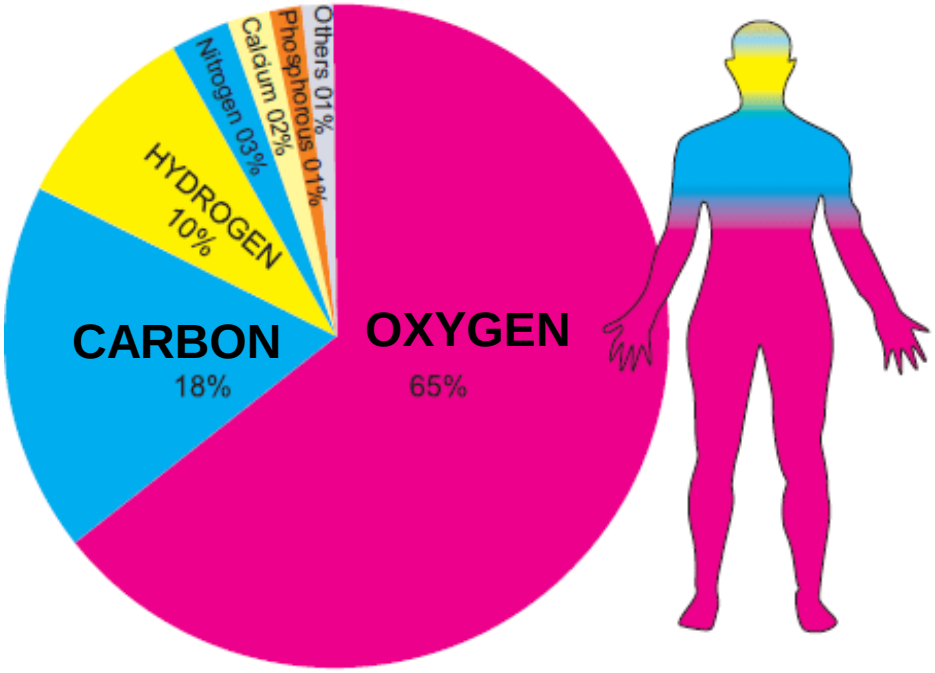
After two weeks:

- ✓ organic compounds
- ✓ sugars
- ✓ amino acids
- ***NO nucleic acids…***

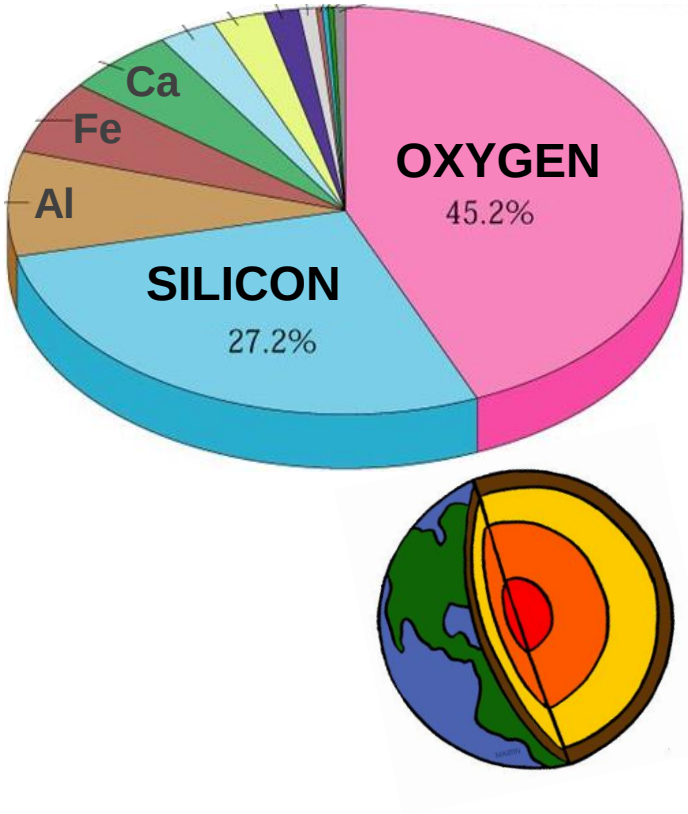
What is life made of?

Approximate <u>elemental composition</u> **(% of chemical element by mass)**

of a human body…

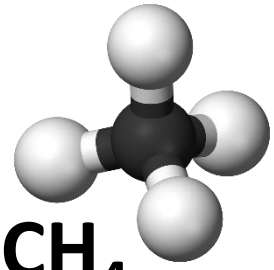


…vs Earth's crust

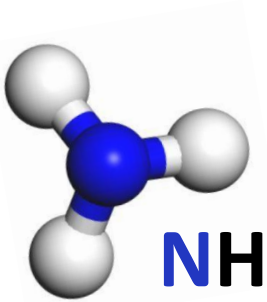


life is carbon-based

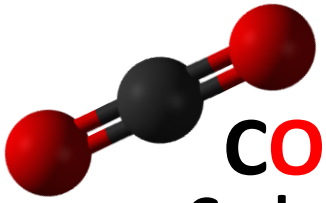
Simple inorganic molecules



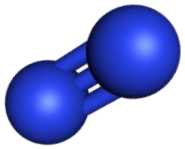
CH_4
Methane



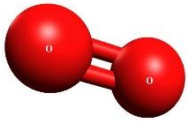
NH_3
Ammonia



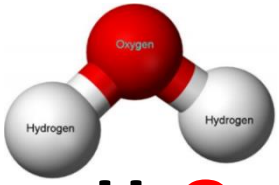
CO_2
Carbon Dioxide



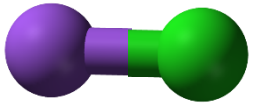
N_2, Nitrogen



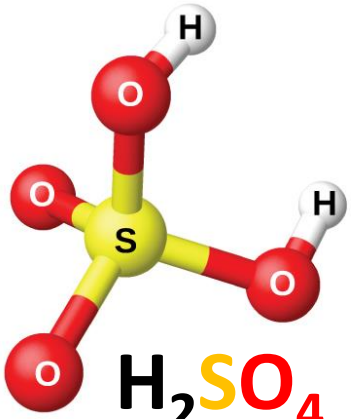
O_2, Oxygen



H_2O
Water



NaCl
Table Salt



H_2SO_4
Sulfuric Acid

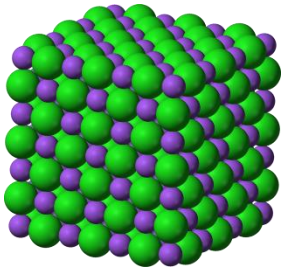
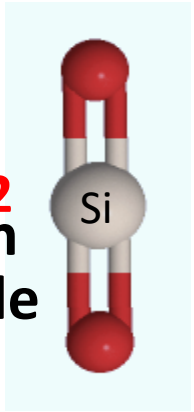


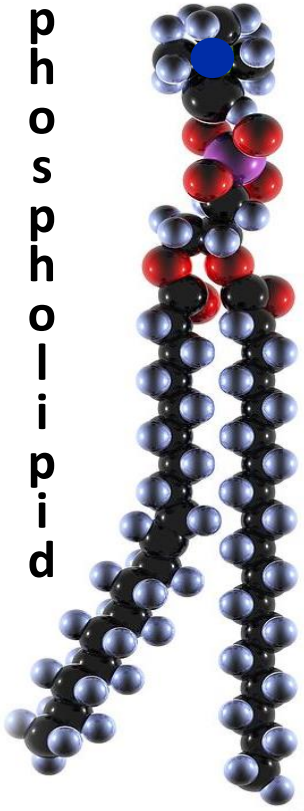
Table Salt crystal



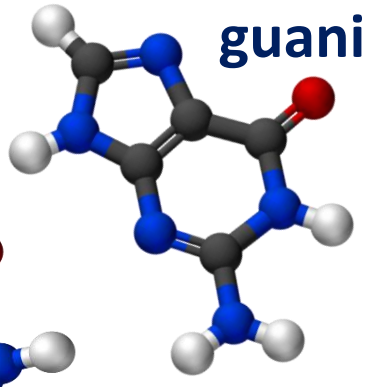
SiO_2
Silicon Dioxide

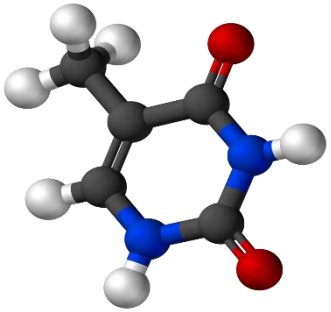
Quartz (sand) crystal

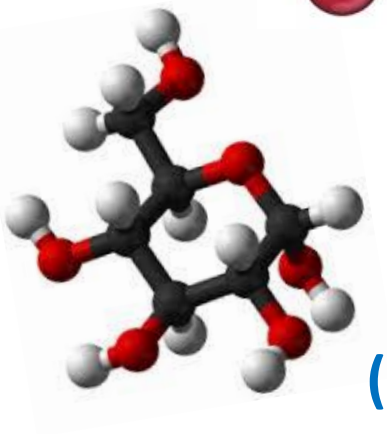
Simple organic molecules



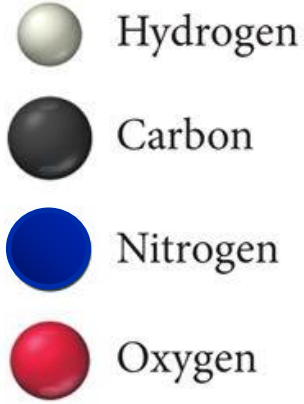
nucleotides:



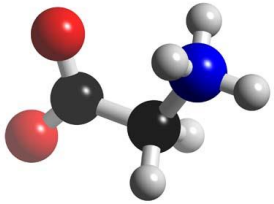




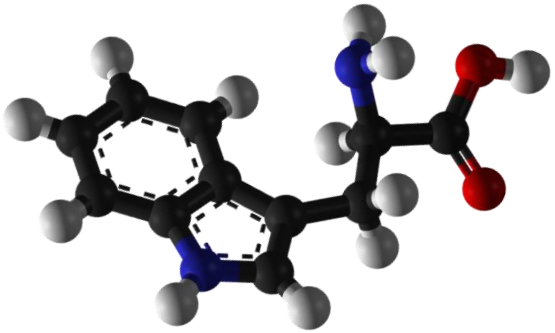
simple sugar (glucose)



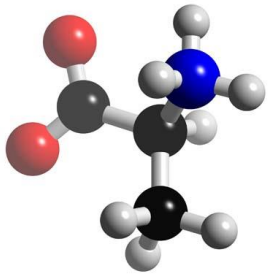
amino acids:



glycine



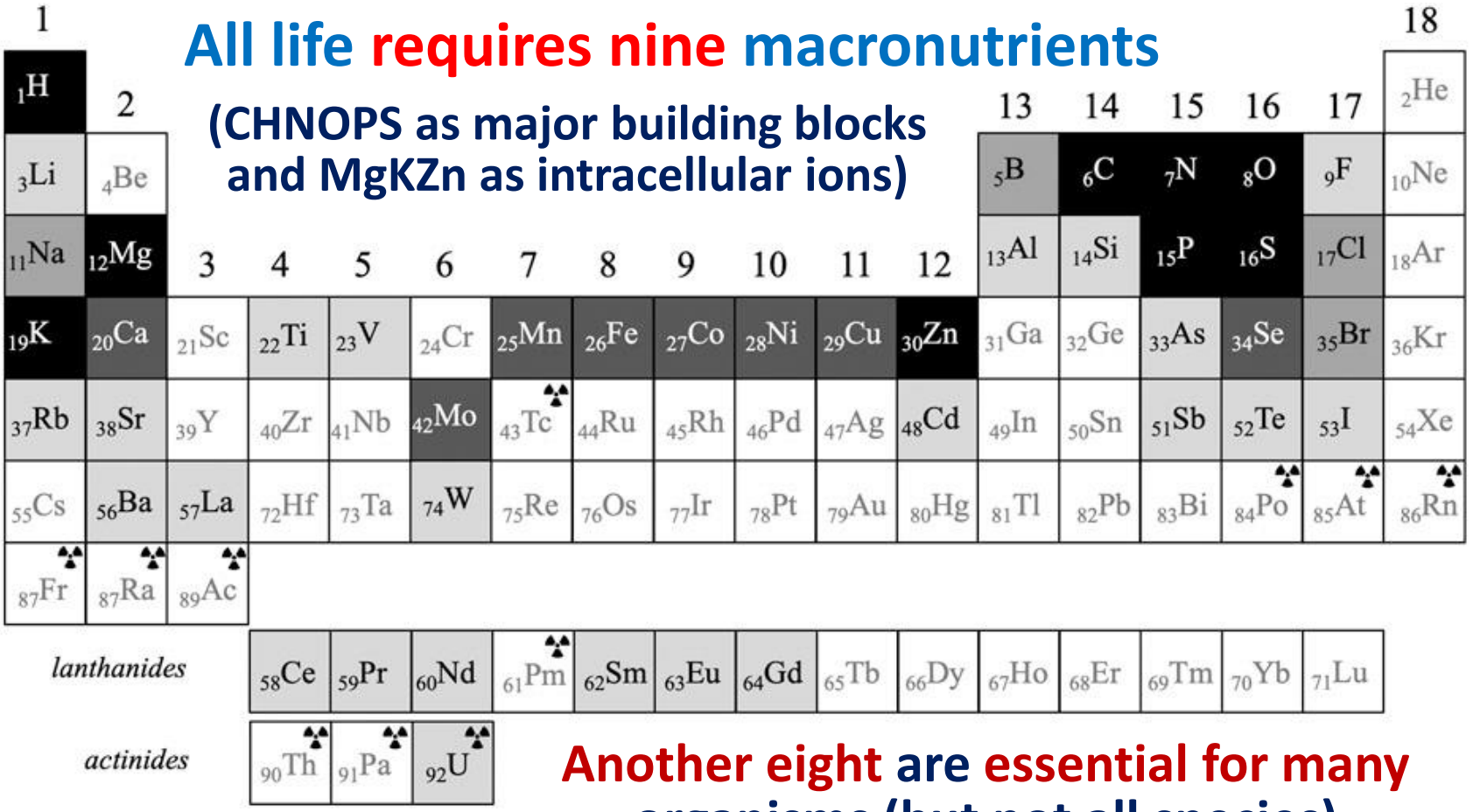
tryptophan



alanine

Biocentric periodic table of elements

essential for all | essential for many | beneficial for many | beneficial for some | no known beneficial use

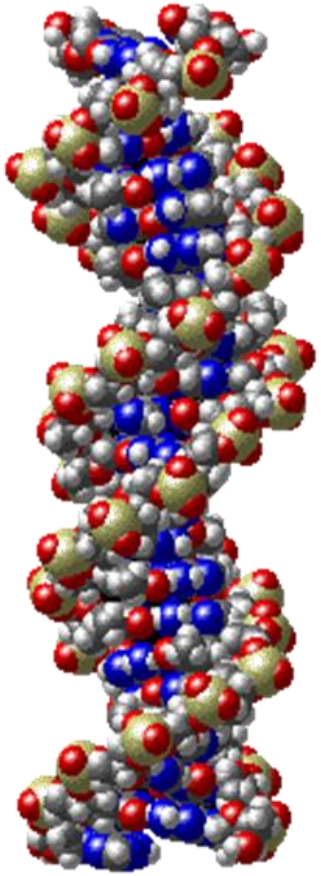


All life requires nine macronutrients

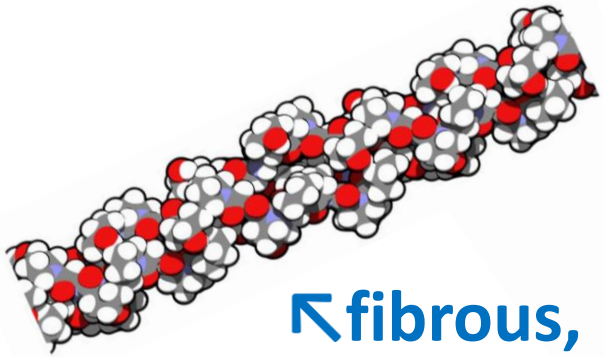
(CHNOPS as major building blocks and MgKZn as intracellular ions)

Another eight are essential for many organisms (but not all species)

Complex organic molecules



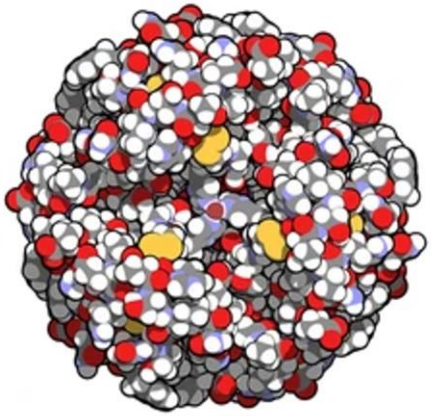
DNA
(fragment)



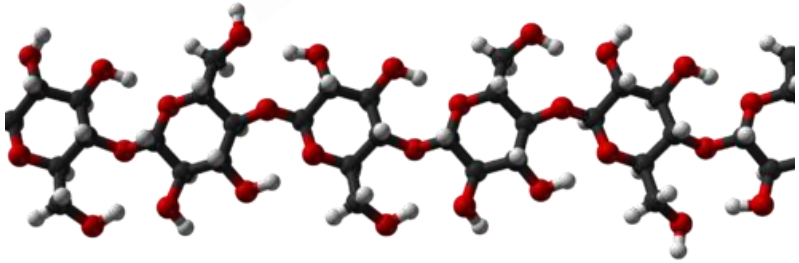
↖fibrous, fragment

PROTEIN

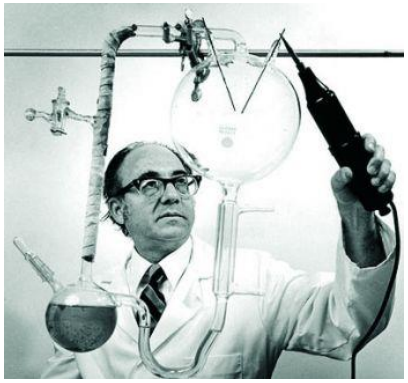
↓globular



LIPID
(triglyceride)

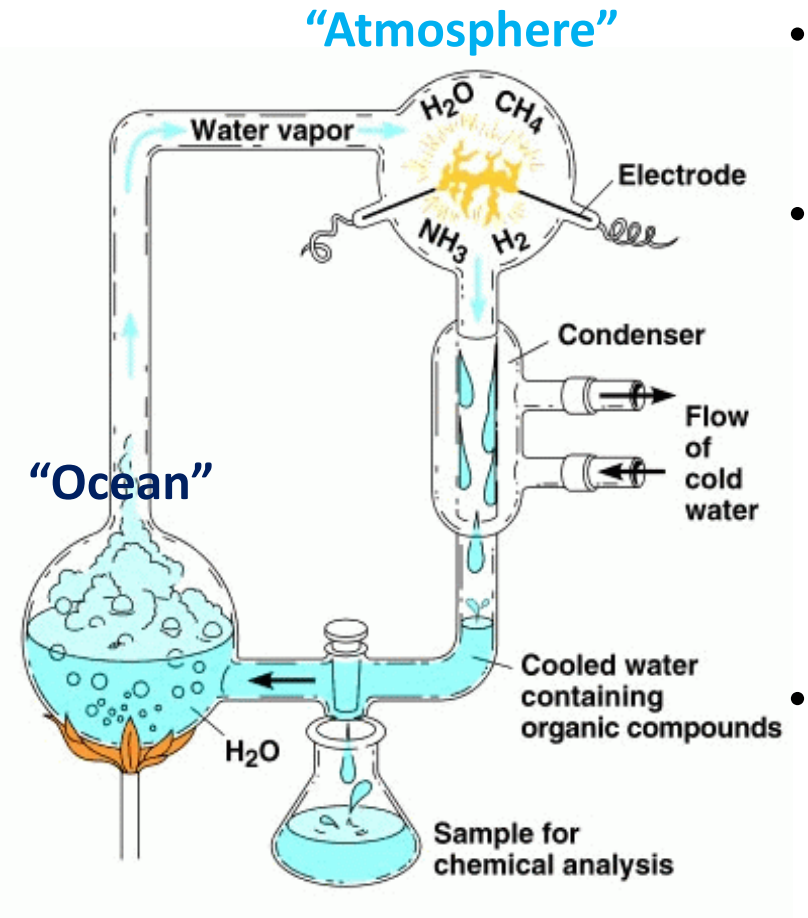


POLYSACCHARIDE
(cellulose, fragment)



Miller–Urey experiment, 1953: chemical origins of life

Stanley L. Miller Harold C. Urey



- **Test for the occurrence of chemical origins of life by simulating the conditions thought at the time to be present on the early Earth.**
- **The experiment used water (H_2O), methane (CH_4), ammonia (NH_3), and hydrogen (H_2) all sealed inside a sterile loop array of glass flasks; one flask was half-full of liquid water ("ocean") and another flask contained a pair of electrodes. The liquid water was heated to induce evaporation, sparks were fired between the electrodes to simulate "lightning through the atmosphere" and water vapor; then water could condense and trickle back into the first flask in a continuous cycle.**
- **After two weeks: 10–15% of the carbon was now in the form of organic compounds; >20 amino acids formed; sugars were also formed. However, *nucleic acids were not formed* within the reaction…**