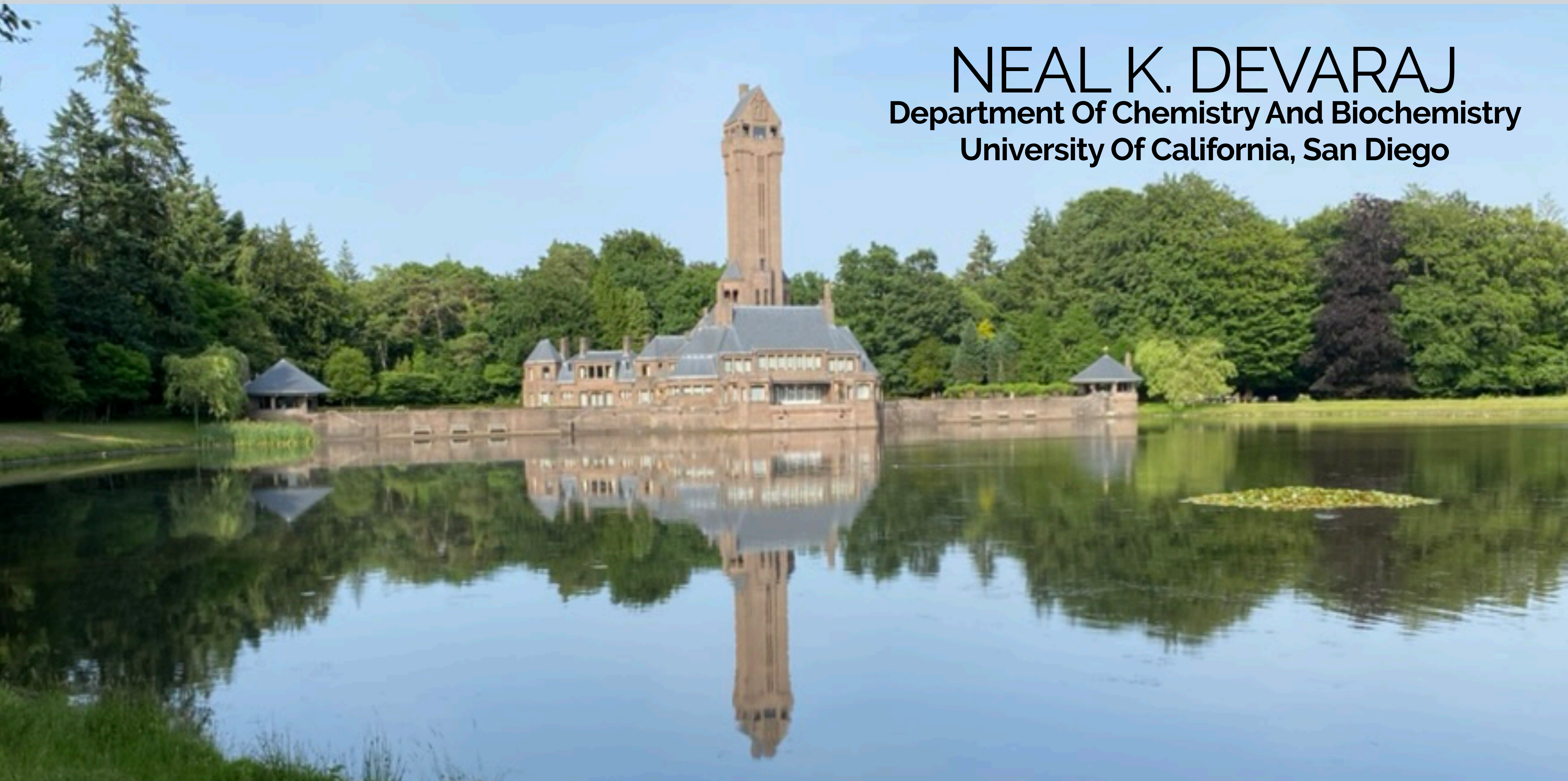
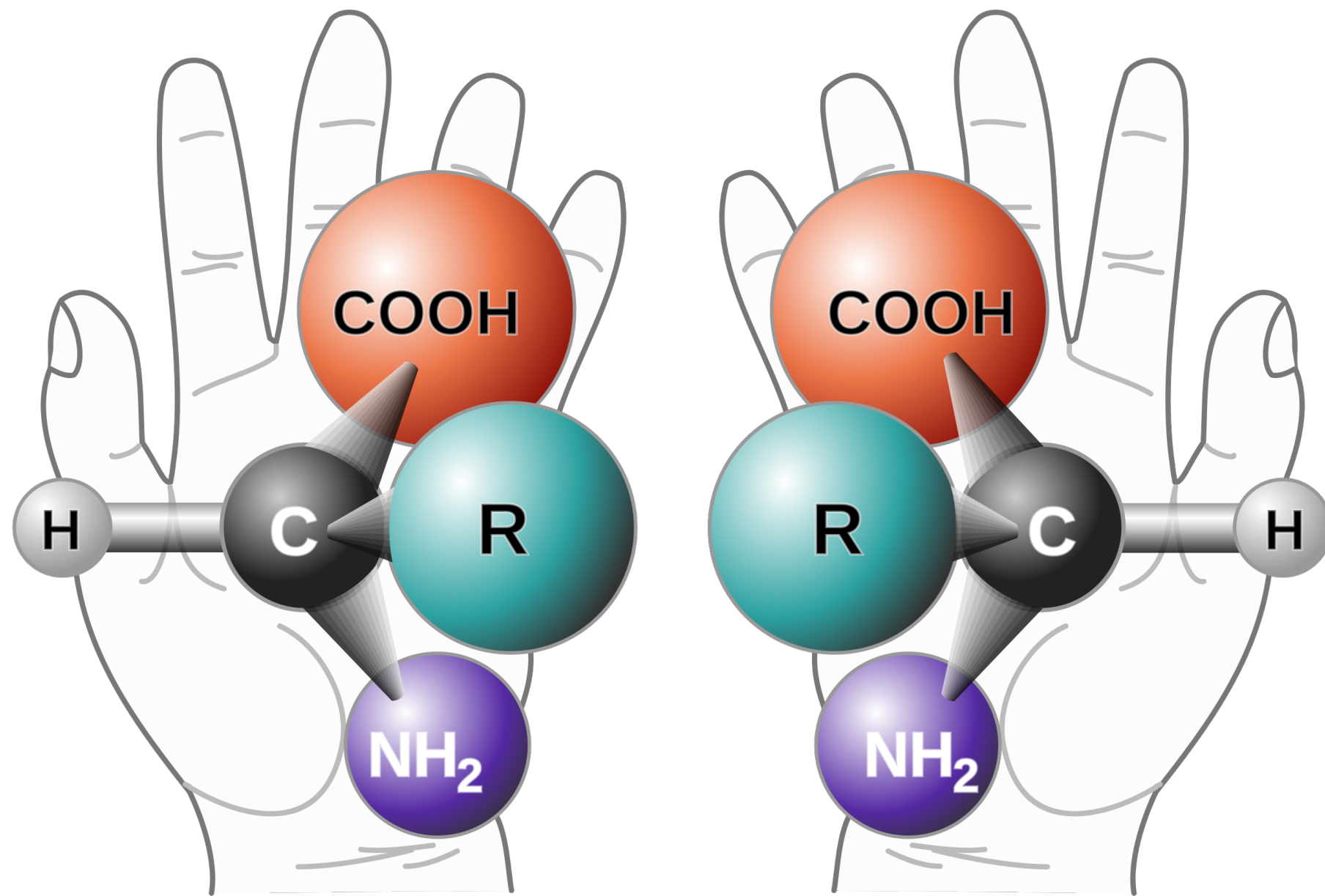


Origin of Homochirality in Biological Matter

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chirality in biology



Proteins - L amino acids

Nucleic Acids - D sugars

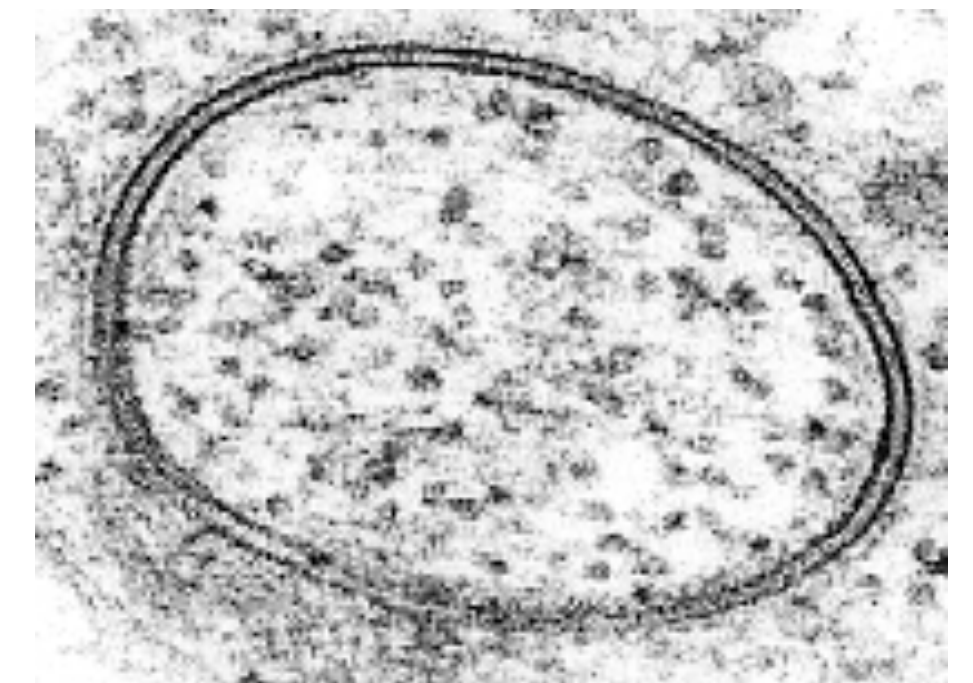
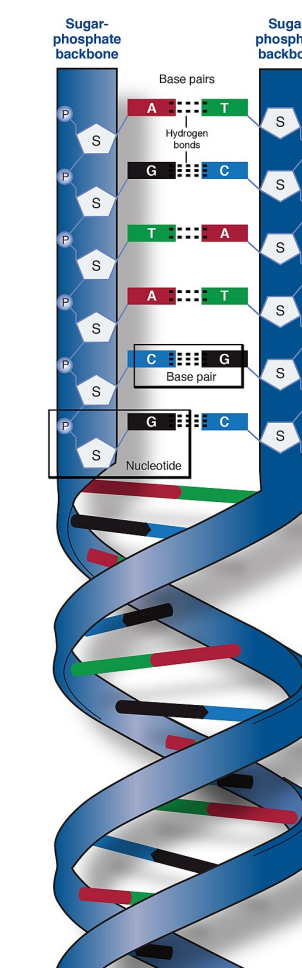
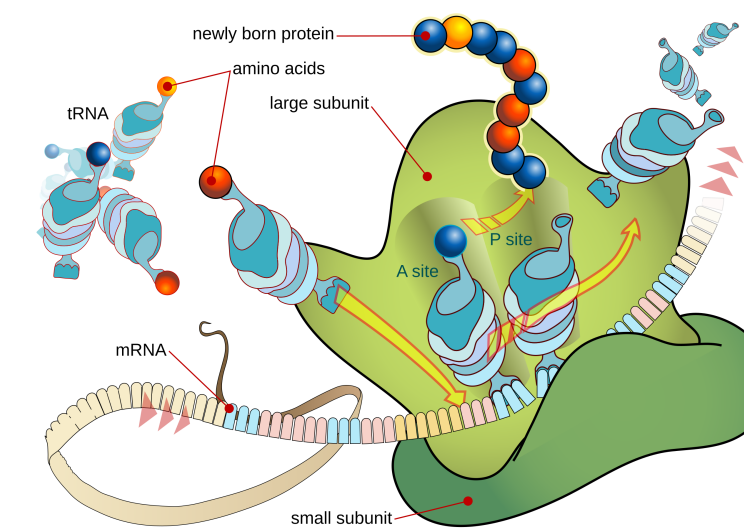
Chirality tied to adoption of specific structures like helices

Lipids - chiral as well but there is a divide:
bacteria/eukaryotes use glycerol-3-phosphate backbones
archaea use glycerol-1-phosphate backbones (mirror orientation)

Matter consisting of molecules that are nearly all of one chirality is one of life's most fundamental features

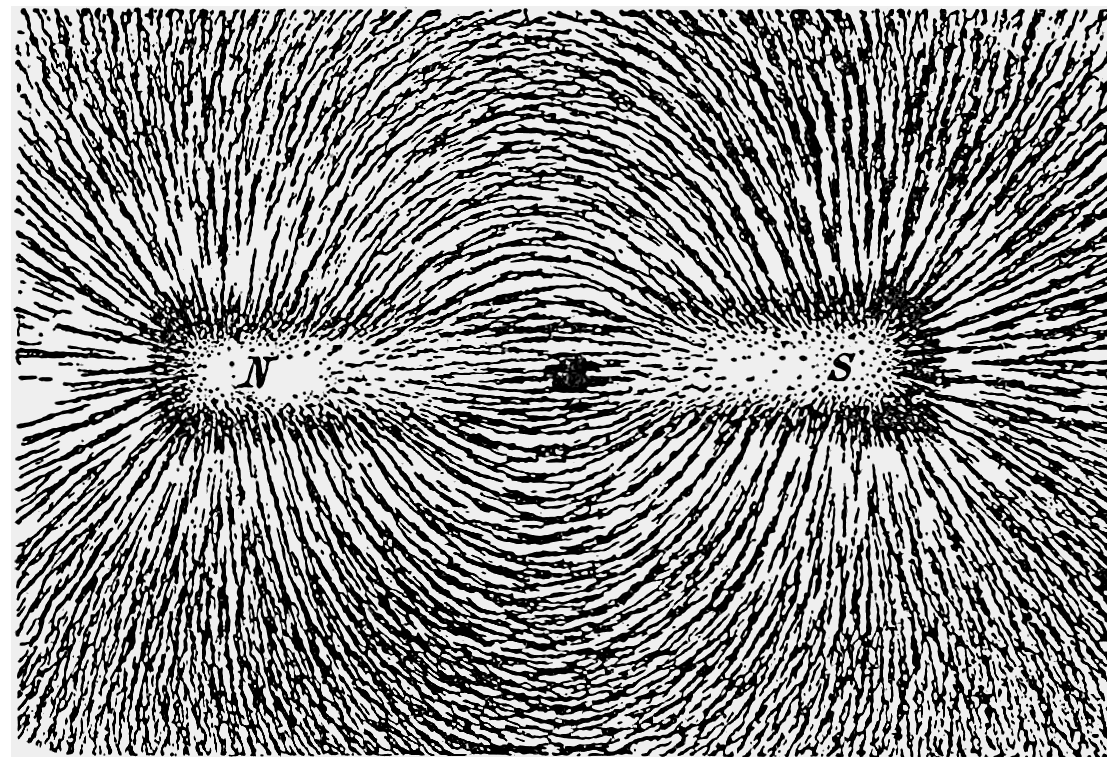
Origin of life: RNA polymerization is inhibited by racemic mixtures

How did homochirality come about? Why these specific orientations? Does all life (synthetic/extraterrestrial) have to adopt these orientations or even have to be chiral

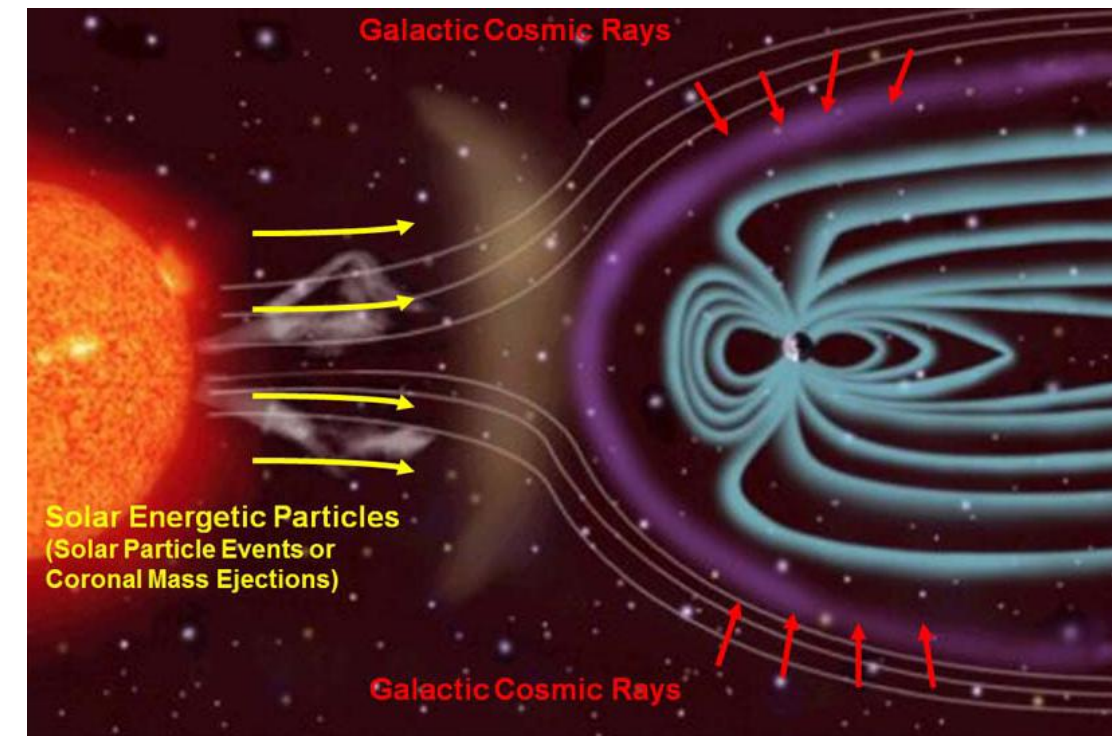


origin of biological homochirality

1. symmetry breaking event



magnetic fields



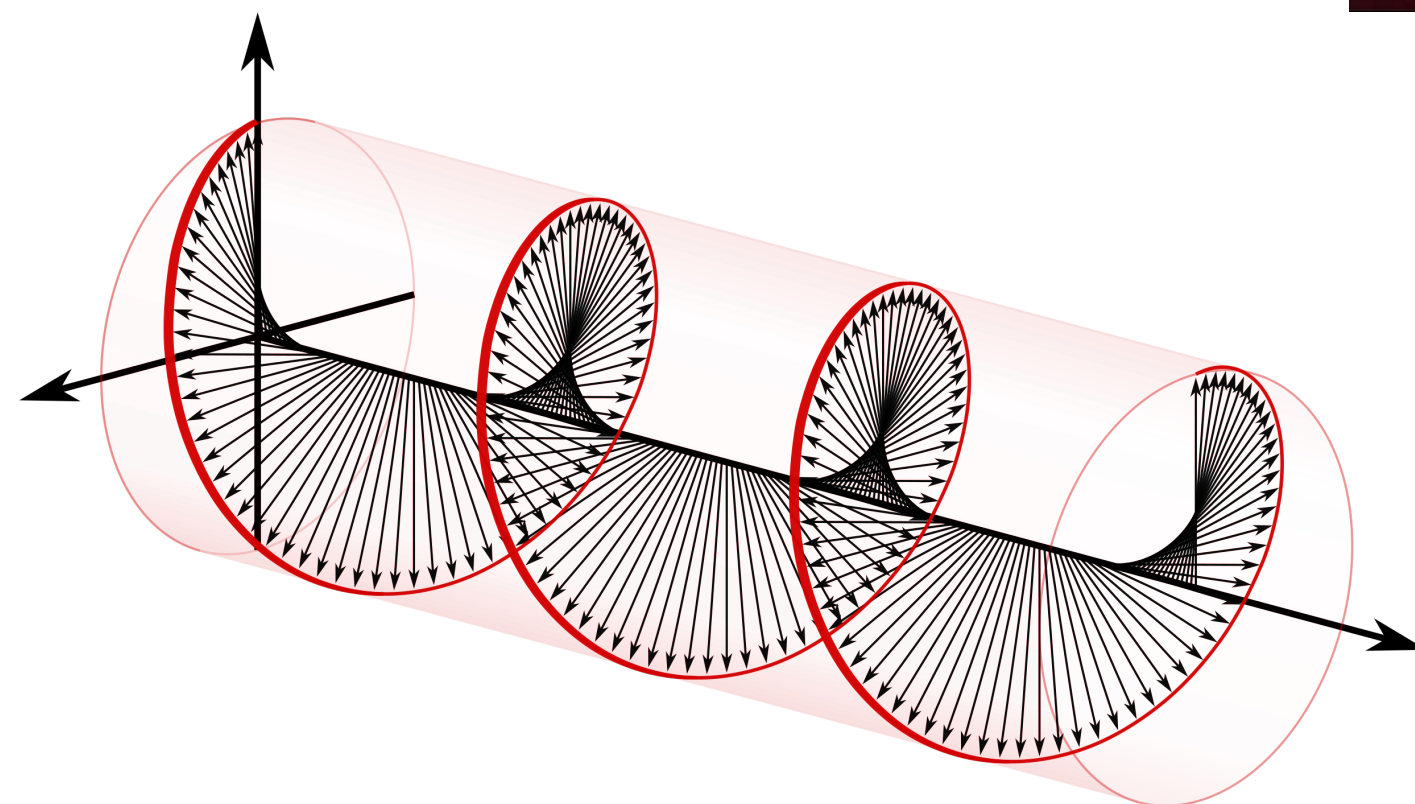
Courtesy NASA/JPL-Caltech

cosmic rays

parity violation

chiral induced spin selectivity

chance?



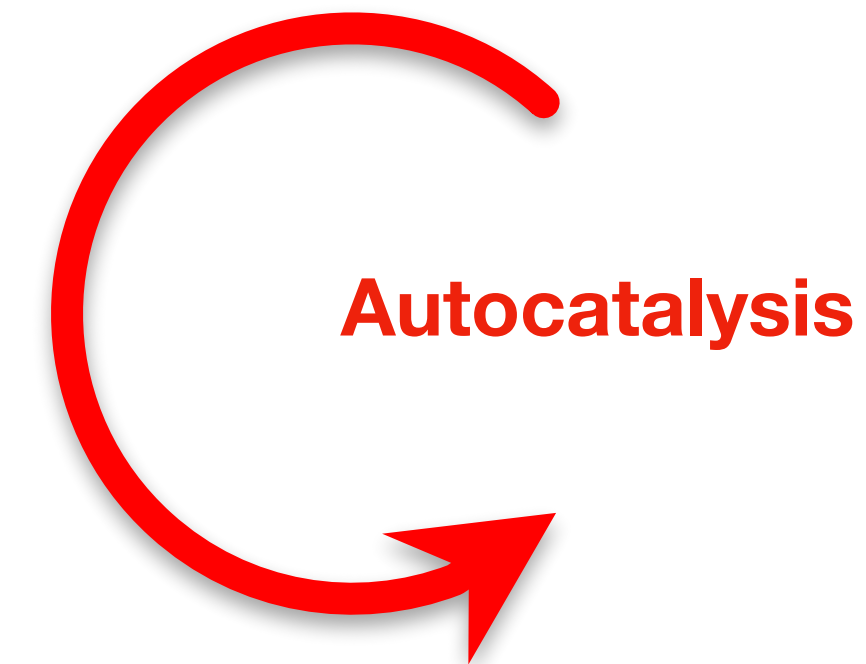
circularly polarized light

what impact (if any) on lab mirror biology?

2. amplification of initial imbalance

chemical

physical



crystallization

lots of debate and no consensus

unclear if there was a preference for one kind of handedness vs another

opposite handed molecules exist in biology

homochirality is not absolute in nature

many organisms including mammals use/manipulate chirality in their building blocks and biopolymers

relies on enzymes like racemases, epimerases, and non-ribosomal peptide synthesis machinery

D-amino acids released by bacteria in high concentrations used in synthesis of bioactive peptides

cell walls of bacteria incorporate D-amino acids (e.g. Ala, Glu) protease resistance

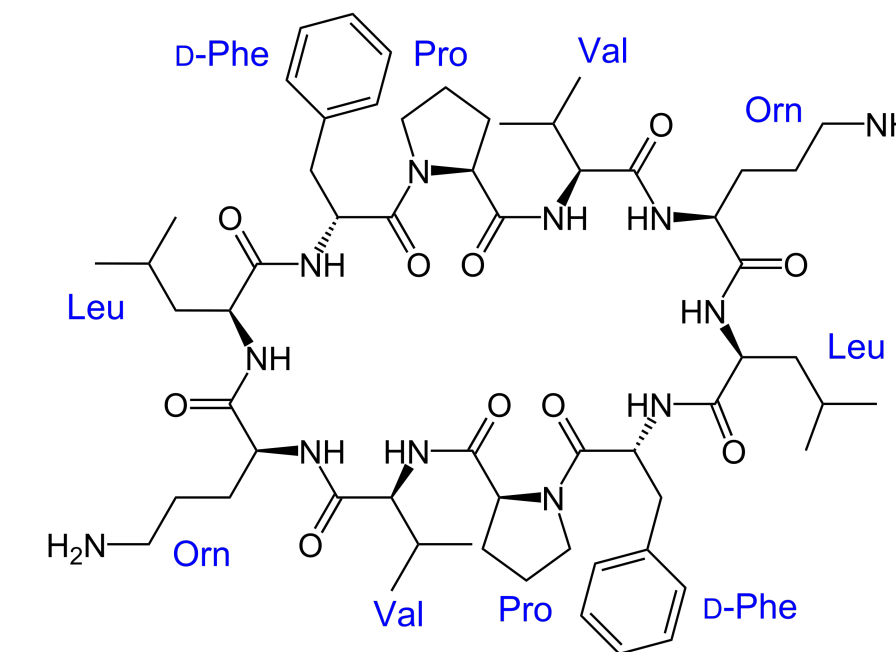
mammalian D-Serine possible neurotransmitter in brain

D-amino acids of bacterial origin in humans

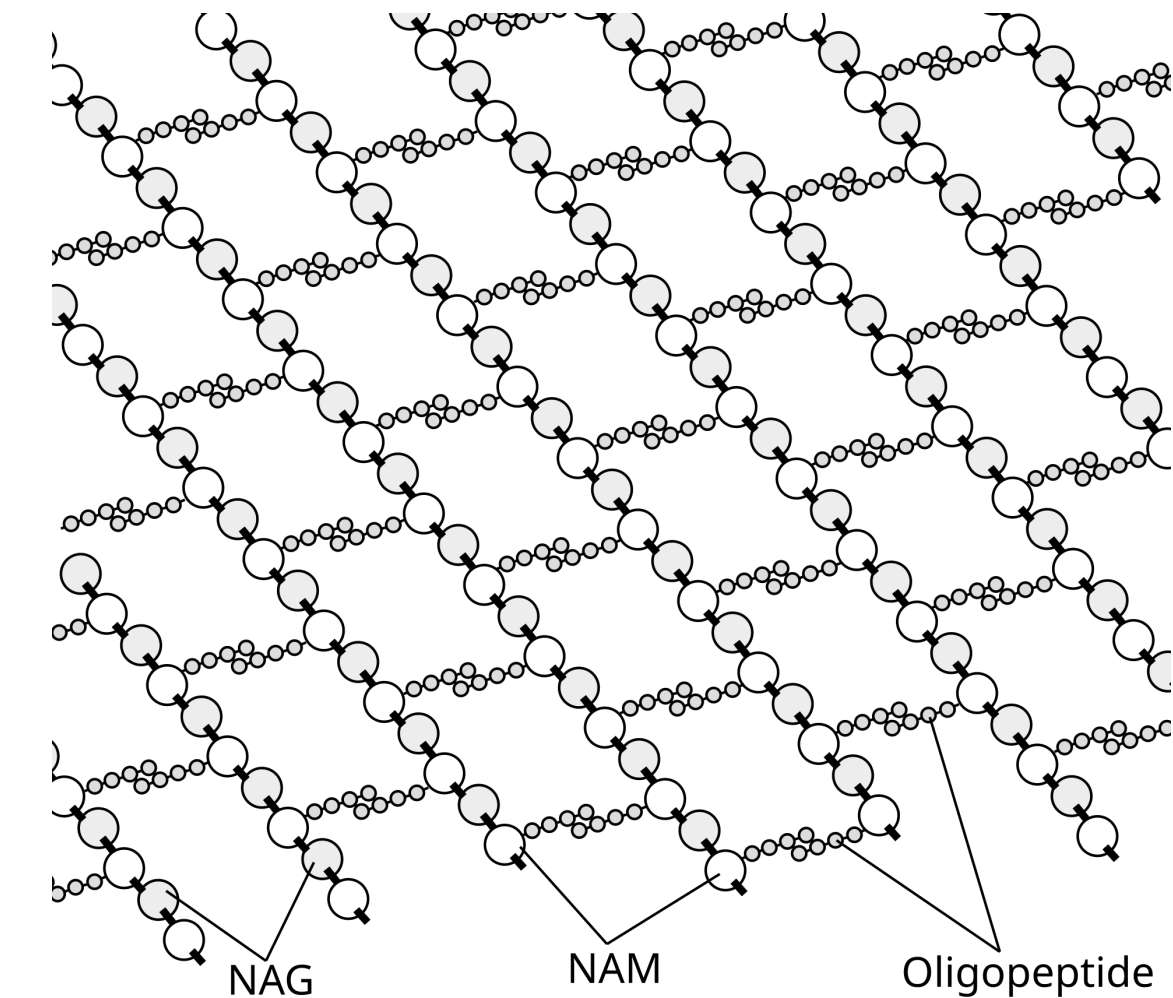
host catabolism of microbial D-amino acids

a special example is the lipid divide

glycans in biology have diverse stereochemistry



Gramicidin-S



peptidoglycan

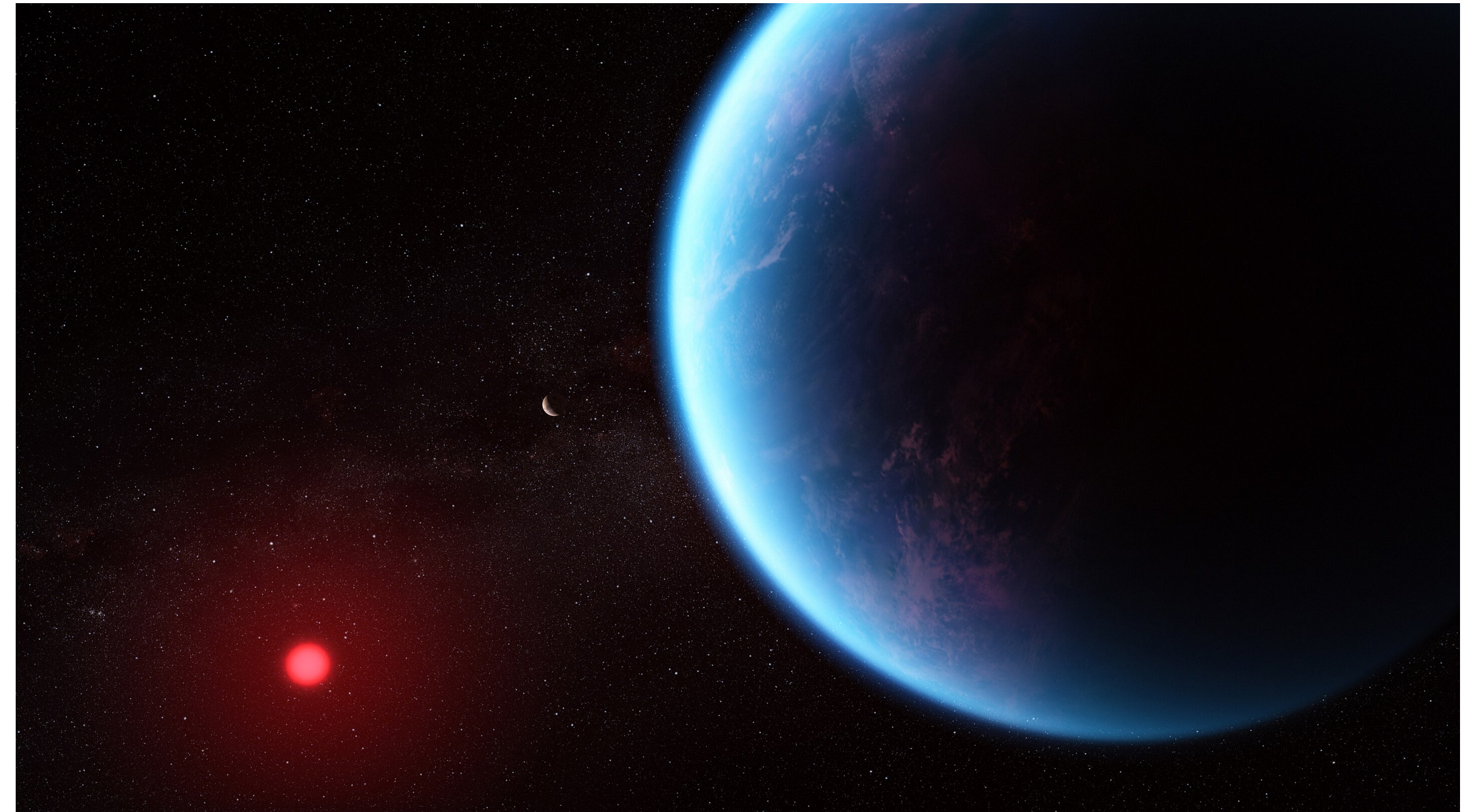


archaea



bacteria

could other chiral forms of life exist?



The universe is an asymmetrical entity. I am inclined to believe that life as it is manifested to us must be a function of the asymmetry of the universe or of the consequence of this fact. The universe is asymmetrical; for if one placed the entire set of bodies that compose the solar system, each moving in its own way, before a mirror, the image shown would not be superimposable on the reality.

-Louis Pasteur