

DOUBLE HYDROGEN BONDING BETWEEN SIDE CHAIN CARBOXYL GROUPS IN AQUEOUS SOLUTIONS OF POLY(BETA-L-MALIC ACID): IMPLICATION FOR THE EVOLUTIONARY ORIGIN OF NUCLEIC ACIDS.

B. R. Francis, K. Watkins, J. Kubelka

University of Wyoming (BrianRF@uwyo.edu)

The RNA world hypothesis holds that in the evolutionary events that led to the emergence of life RNA preceded proteins and DNA, and is supported by the ability of RNA to act as both a genetic polymer and a catalyst. Conversely, biosynthesis of nucleic acids requires a large number of enzymes and chemical synthesis of RNA under presumed prebiotic conditions is also complicated and requires many sequential steps. These observations suggest that biosynthesis of RNA is the end product of a long evolutionary process. If so, what was the original polymer from which RNA and DNA evolved? Most syntheses of polymers that are simpler than RNA alter the D-ribose phosphate backbone but retain purines and pyrimidines for hydrogen bonding between complementary base pairs. However, the bases are themselves products of complex biosynthetic pathways and hence they too seem to have evolved from simpler polymer side chains that had the ability to form hydrogen bonds. Our hypothesis is that the earliest evolutionary predecessor of nucleic acids was the simple linear polyester, poly(beta-D- malic acid), which used its carboxyl side chains to form double hydrogen bonds. In accord with this hypothesis, experimental evidence is presented showing that the closely related polyester, poly(beta-L-malic acid), uses carboxyl side chains to form robust intramolecular double hydrogen bonds in moderately acidic solution. This hypothesis reconciles the 'genetics first' and 'metabolism first' approaches to the origin of life.