THE RNA WORLD HYPOTHESIS

- The RNA world is a hypothetical stage in the evolutionary history of life on Earth, in which self-replicating RNA molecules proliferated before the evolution of DNA and proteins. The term also refers to the hypothesis that posits the existence of this stage.
- The concept of the RNA world was first proposed in 1962 by Alexander Rich, and the term was coined by Walter Gilbert in 1986. Alternative chemical paths to life have been proposed and RNA-based life may not have been the first life to exist. Even so, the evidence for an RNA world is strong enough that the hypothesis has gained wide acceptance.
- The central role for many proteins in a cell is to catalyse chemical reactions that are essential for the cell's survival. These proteins are known as enzymes. Until relatively recently, it was thought that proteins were the only biological molecules capable of catalysis.
- In the early 1980s, however, research groups led by Sidney Altman and Thomas Cech independently found that RNAs can also act as catalysts for chemical reactions. This class of catalytic RNAs are known as ribozymes, and the finding earned Altman and Cech the 1989 Nobel Prize in Chemistry.
- The ribozyme isolated by the Cech group, known as the Tetrahymena ribozyme, is shown in the box to the right. It acts to cut a longer strand of RNA into two smaller segments.
- The discovery of ribozymes supported a hypothesis, known as the RNA World Hypothesis, that earlier forms of life may have relied solely on RNA to store genetic information and to catalyze chemical reactions.

- This hypothesis was proposed independently by Carl Woese, Francis Crick and Leslie Orgel in the 1960s -- decades before the discovery of ribozymes -- and soon after the double-helical structure of DNA was determined. According to the RNA World Hypothesis, life later evolved to use DNA and proteins due to RNA's relative instability and poorer catalytic properties, and gradually, ribozymes became increasingly phased out.

- Perhaps the strongest evidence for the RNA World Hypothesis is the fact that the ribosome, a large molecular complex that assembles proteins, is a ribozyme. Although the ribosome is made up of both RNA and protein components, structural and biochemical analyses revealed that the mechanisms central for translation (the process of assembling a peptide chain based on a RNA sequence) is catalyzed by RNA, not protein. This suggests that the use of RNA by early life-forms to carry out chemical reactions preceded the use of proteins.

- RNA is able to both store genetic information, like DNA, and catalyzes chemical reactions, like an enzyme protein. It may therefore have supported pre-cellular life and been the first step in the evolution of cellular life.

- The RNA world is proposed to have evolved into the DNA, RNA and protein world of today. DNA is thought to have taken over the role of data storage due to its increased stability, while proteins, through a greater variety of monomers (amino acids), replaced RNA's role in specialized biocatalysis. The RNA world hypothesis suggests that RNA in modern cells is an evolutionary remnant of the RNA world.

- **First proto-organisms had both genes and enzymes made of RNA**

- **DNA and proteins as specialized late-comers**
- **DNA took over information storage**
- **Proteins took over enzyme activity**