RNA (ribonucleic acid) and DNA (deoxyribonucleic acid) are both nucleic acids, consisting of sequences of nitrogen-containing bases joined by sugar-phosphate backbones. RNA is usually single-stranded, whereas DNA is double-stranded. RNA has the nitrogen-containing base uracil in place of DNA's thymine. RNA comes in a variety of different shapes. Double-stranded DNA is a staircase-like molecule. RNA nucleotides include the sugar ribose (with oxygen in the 2' position), rather than the deoxyribose (without oxygen in the 2' position) that is part of DNA. Functionally, DNA stores genetic information, whereas RNA actively utilizes that information to enable the cell to synthesize a particular protein

The presence of the oxygen in the 2' position of the ribose is the major cause of RNA instability when tested in vitro, outside a cellular context. Indeed, this reactive oxygen can attack and cleave 5'-3' phosphodiester bonds, a reaction that is considerably enhanced in the presence of bivalent ions and by increasing the temperature. Hence, DNA lacking this 2' hydroxyl group, when tested under identical conditions as RNA of the same size has a much longer lifetime. Moreover, the modification of uracil to thymidine (C5-methylation) further stabilizes the DNA by allowing the formation of rigid stretches of double stranded helices, possibly supercoiled into a very compact tertiary structure, a conformation that is much more stable than any RNA in solution. Lastly, once free rotation between the two DNA strands is prevented by circularization (in covalently closed circular molecules) DNA become fairly resistant to thermodenaturation. Because of its superior stability over RNA, it is generally assumed that DNA was naturally selected as genetic material, allowing the emergence of larger genomes, a prerequisite for the evolution of life toward more complexity.