The natural world has been "computing" since life began. Many of these computing mechanisms in nature (such as Artificial Neural Networks, DNA Computing, and Cellular Computing) have been studied in order to find new computing paradigms. Recently, a new area in natural computing has been introduced called Membrane Computing which looks at the manner in which cellular membranes control the evolution and communication of the objects they contain with the environment. The biological cell consists of proteins, enzymes, molecules, etc. (generically referred to as objects) surrounded by a membrane. This membrane is used to separate these objects from the environment surrounding the cell. The membrane allows controlled exchanges of these objects with the environment along with facilitating the evolution of objects (changing protein 'a' into protein 'b') within the membrane. These natural processes can be viewed as a computation. Membrane computing explores, abstracts, and formalizes this new method of computation inspired by the natural membrane model. A number of membrane system models have been examined and most have been found to be computationally complete (i.e. equivalent is computing power to a Turing Machine) along with offering advantages over our current computing models.

Currently our computers are based on a model of computing which use a centralized, deterministic, sequential mode of operation. The natural cellular world however, uses a decentralized, nondeterministic, maximally parallel mode of operation. By exploiting the decentralized, parallel power of membrane systems we are able to solve some problems much faster than with our current silicon computers. This distinction can be seen by looking at NP-complete problems (which take an exponential amount of time to solve using deterministic, sequential systems). Some membrane system models have been found to be able to solve NP-complete problems in polynomial (and usually linear) time by operating in a fully parallel manner and trading space for time.

In this talk, the area of membrane computing is introduced and many of the current models are defined and explored in terms of both computability and complexity. Most of these models have been shown to be computationally complete. Next, restrictions to these models are discussed. We will look at restricted systems in terms of the number of membranes, the number of objects, and the size of the rules. We find some features of systems are unnecessary in terms of computing power while others lead to non-universal systems.