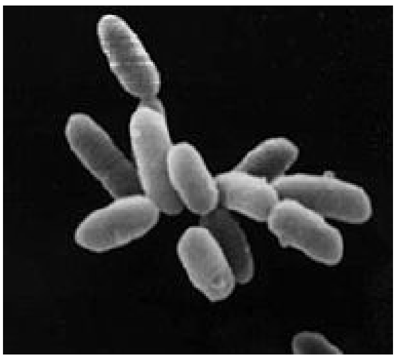
Molecular Switch

The ability of **Biomolecules** to work as switching devices in computers is a major area of research in the present day with the invention of some bacterial proteins which functions exactly similar to the electronic switches. These **Molecular switches** increase the possibility of fast **random access** and **transportability** of datas in Multimedia systems. If these are used in computers, appreciable amount of size reduction, fast memory access, mass storage of datas etc can be achieved. The invention of the light sensitive protein **Bacteriorhodopsin** from the **Halobacterium salinarium** has generated great interest among scientists to use it as a **Molecular switch**.

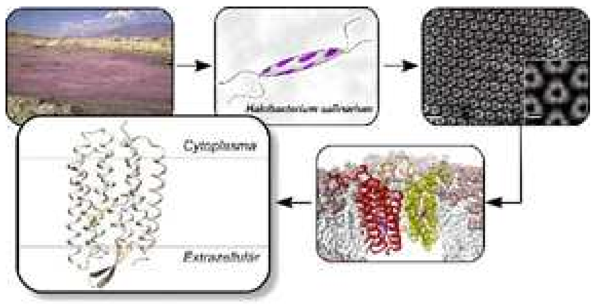
It is possible to create **Molecular biochips** using the **Hybrid technology**. It combines both biomolecules and semiconductor materials to create the biochips. Several biomolecules such as DNA, Proteins etc have been experimented in hybrid technology. The bacterial protein **Bacteriorhodopsin** from Halobacterium salinarium has created great interest among scientists to produce bio-logic gates functioning similar to semiconductor logic gates.

Halobacterium salinarium

It is a bacterial species living in the **salt marshy lakes of California**. These bacteria can survive at very high temperature of **150 degree** Fahrenheit or more and in high salt concentration around six times higher than the sea water. These bacteria have a light sensitive protein called **Bacteriorhodopsin (bR)** in their cell membrane. This protein exhibits unusual properties of structural changes when exposed to different wavelengths of light. This property of the Bacteriorhodopsin is exploited to create molecular switches.

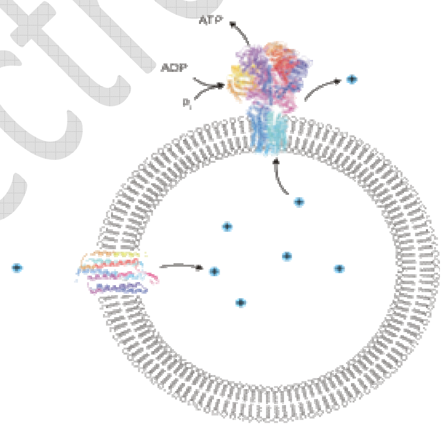


Halobacterium salinarium



About Bacteriorhodopsin (bR)

It is the light sensitive, heat stable protein present in Halobacterium salinarium. The bR absorbs different wavelengths of light and changes its structure into different forms. For example when it absorbs Red light, its structure changes into one form and retains the structure. When it absorbs Green light, another structure is formed. Thus by exposing to Red and Green lights, it is possible to change the structure of bR exactly similar to the semiconductor logic gates giving high and low outputs in varying voltages. The Thermal and photochemical characteristics of bR makes it as a good choice to create molecular switches. The bR also has specific **Optical properties** suitable to create **Optical memories. Walther Stockenius** of **California University** and **Dicter Osterhelf** of **Maxplanck** Institute of **Biochemistry** first noted the unusual light sensing properties of Bacteriorhodopsin.



Bacteriorhodopsin

Photo cycle of Bacteriorhodopsin

The energy absorbing material in the Bacteriorhodopsin is called as **Chromophore** that absorbs the incident light energy and triggers a series of photochemical changes. These changes cause alteration in the optical and electrical characteristics of bR. The photochemical change of bR at different wavelengths light is

1. Green light changes the initial structure **bR** to **K form**
2. **K form** then relaxes into **M form** and then into **O form**
3. Red light changes **O form** into **P form**
4. **P form** then relaxes to become a stable **Q form**
5. Blue light changes the stable **Q form** into initial **bR** form again.

So any two forms of the bR can be compared to the **binary codes 1 and 0** and the **1 and 0 states** of logic gates.

Electronics of bR

The light induced switching between the **bR** and **K forms** of Bacteriorhodopsin can be exploited to create molecular switches that work much faster than the semiconductor gates. The conversion of bR and K forms shows a speed of a few **trillionth** of a second. The bR chips can be created using a number of bR molecules in a **3D fashion**. These chips can have high speed and high density capabilities. **Read** and **Write** operations can also be done using different colors of **Laser** beams. The entire data processing, retrieval, data storage etc can be done in a **milli second**. The **bR Arrays** can be arranged to form **bR Cubes** that functions as Photosensitive Molecular switches. When light passes through these cubes, they senses 1 and 0 states and give corresponding outputs. The cubes detect the **luminescent power** of light and convert it into corresponding **electrical outputs**.

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