Jellyfish and Chemistry Nobel Prize, 2008

Jellyfish or crystal jelly, Aequorea victoria, (Figure 1) is a bioluminescent hydrozoan found off the west coast of North America. In 1962, Professor Osamu Shimomura isolated a green fluorescent protein (GFP) from this Jellyfish. The protein glows bright green under ultraviolet light. It was isolated along with the bioluminescent protein aequorin that reacts with calcium ions and releases blue light (Figure 2). Aequorin is a photoprotein (composed of two units : an apoaequorin (189 amino acids) and luciferin – coelenterazine)). The GFP is composed of 238 amino acids.

The discovery of green fluorescent protein (GFP) has revolutionised research in medicine and biology (Table 1). It enables scientists to get a visual fix on how organs function, the spread of disease and the response of infected cells to treatment. This glowing protein is used as a tag to illuminate previously invisible biochemical processes deep within cells, for example, it will show how brain cells develop or how cancer cells spread through tissue. By tagging nerve cells, scientists can for instance follow the destruction caused by Alzheimer's disease. They are now even incorporated into bacteria to act as environmental biosensors in the presence of toxic materials.

Figure 1 : The jellyfish Aequorea and its light emitting organs. Light emitting organs are located along the edge of the umbrella[3].

Osamu Shimomura (Marine Biological Lab, MA & Boston Medical School, MA, USA) together with Martin Chalfie (Columbia University, USA) and Roger Y. Tsien (Howard Hughes Medical Institute, University of California, USA) were awarded the 2008 Nobel Prize in Chemistry for the discovery and development of the green fluorscence protein (Table 1). It may be worth-while to cite a quote from Osamu Shimomura's review article about the discovery of aequorin and GFP that 'it is important not to give up when a difficult problem is encountered in research, but overcoming a difficulty may reward us with a self-belief that could be more valubale than the solution to the problem'.

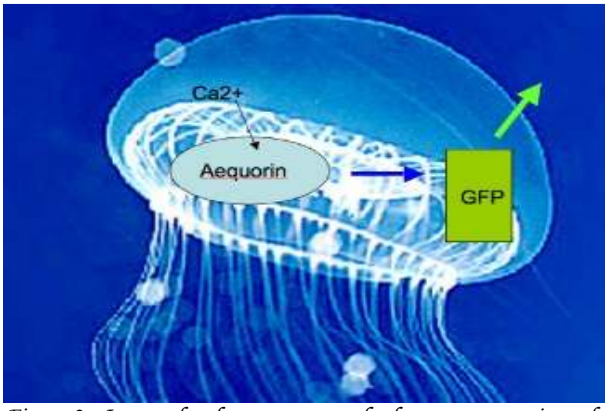

Figure 2 : Intermolecular energy transfer between aequorin and GFP in jellyfish. In order to bioluminesce Aequorea victoria, release calcium ions. These binds to a protein called 'aequorin', which releases blue light upon calcium binding. The blue light is absorbed by green fluorescent protein, which in turn gives off the green light[2,6].

Table 1: Green fluorescence protein research & development (1955-2008)

1955 : Green fluorescent substance in jelly fish described
1962 : Green fluorscence protein extracted from jellyfish
1969 : Green protein named green fluorscence protein
1974 : Intermolecular energy transfer between aequorin and GFP in jellyfish reported
1979 : Structure of chromophore characterized
1985 : Cloning and expression of Aequorin
1992 : GFP cloned
1994 : GFP expressed in E. coli and C. elegans.
1996 : First crystal structures of wild-type and enhanced GFP
1999 : Red fluorescent proteins (DsRed) discovered in anthozoan corals
2000 : Fluorescent timer protein; the difference between green fluorescent protein and it's red analog reported
2002 : Monomeric DsRed, first photoconverible and photoactivatable FPs created
2004 : New "fruit" FP's generated by in vitro and in vivo directed evolution
2007 : FP found in amphioxus, first time in chordates
2008 : The first mutant of the Aequorea victoria GFP that forms a red chromophore reported
2008 : Chemistry Nobel Prize for research & development on GFP

References and further reading
1. Kendall, J.M. and Badminton, M.N. 1998. Aequoria Victoria bioluminescence moves into an exciting new era. TibTech. 16, May, pp 216-224
2. Morise,H., Shimomura,O., Johnson,F.H., and Winant, J. 1974. Intermolecular Energy Transfer in Bioluminescent systems of aequorea. Biochemistry 13 : 2656-2662
3. Shimomura, O. 2005. The discovery of aequorin and green fluorescent protein. Journal of Microscopy, vol. 217, pt 1. January, pp. 3-15
4. http://en.wikipedia.org/wiki/aequorin; 5. http://en.wikipedia.org/wiki/green_fluorescent_protein;
6. http://www.conncoll.edu/ccacad/zimmer/GFP-ww/timeline.html