The Next Big Thing: Self-assemblies and the Energy crisis

Two weeks ago I had the opportunity of attending one of the many seminars hosted by SSE. The seminar, titled "Next Big Thing" was on self assembling bionanomaterials, Photonics and Biological gold mines and the speaker was Mohammad Safwan Akram, currently a PhD student in Analytical Biotechnology at Cambridge. His research work at Cambridge involved understanding the mechanism by which these particles self-assemble so that they could be manipulated to form specific assemblies that can be used in the field of medicine etc. He also spoke about the idea of harnessing solar energy, for which he was awarded the CambridgeSens Innovative Idea of the Year (read the HEC newsletter entry[1] provided on the SSE Physics Lab website), and why he wants to come back to Pakistan. **This essay attempts to explain Mr. Akram's ideas of synthetic assemblies and their utility, and the use of biological techniques to solve the energy crisis:**

Self-assembling bionanomaterials:

Self-assembling bionanomaterials refers to materials that can polymerize to form long chains in a particular arrangement without any external stimulus in a living as well as a non-living environment. Being able to harness these assemblies to form a particular template has many potential functions. In addition, some peptide sequences have a strong affinity to inorganics (including metals such as titanium). Using these sequences and those for self assembling particles we can make fusion constructs of Genetically Engineered Proteins for Inorganics (GEPI'S). Since the protein can identify inorganic components and can self assemble it would act as a linker between the inorganic components while also contributing to the overall structure and function of the assembly. These proteins may have non-specific binding but a buffer could be used to wash certain peptides off, while the one of our choice can remain attached. The inorganic surface to which they adsorb can be well defined such as a crystal or a nanoparticle but even powder could be used. Once an inorganic surface specific protein has been found it could be modified, redesigned and synthesized to form a molecular construct.[2]

So for instance, if a person has somehow damaged his/her vertebra, using such a construct (including titanium template) containing sequences with affinity for titanium could be implanted in the patient's backbone. The proteins would self assemble around

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[1] (http://physlab.lums.edu.pk/images/e/ed/HEC_newsletter.pdf)

[2] http://www.sciencedirect.com/science?_ob=ArticleURL&_udi=B6TXG-4KCPV4Y-1&_user=4852827&_coverDate=04%2F30%2F2007&_rdoc=1&_fmt=high&_orig=search&_sort=d&_docanchor=&view=c&_searchStrId=1317660216&_rerunOrigin=google&_acct=C000065379&_version=1&_urlVersion=0&_userid=4852827&md5=cae1c163d514e134ca371e882f5b34f2

the template to form a vertebral implant of great tensile strength. Thus, it has enormous potential for usage in implants. In an article at Physorg.com on Nanoparticle Self-Assembly, Dr. Leroy Cronin, a researcher at Glasgow said:

> "This discovery could lead the way for the designed assembly of a whole range of precisely-defined nano-particles with applications in electronics, medicine, and catalysis to allow the design of intelligent or smart nano-sensors and nano-functional machines, not to mention the fundamental implications regarding the assembly of complex chemical systems, the most spectacular example of which are living cells."[3]

Innovative idea of the year:

The crux of the idea is this: when UV radiation from the sun is absorbed by our skin, pyrimidine monomers (present in our DNA - thus forming the very basis of our genetic material) combine to form a dimer. At the same time, an enzyme in human skin called photolyase splits these dimers into respective monomers by donating electrons as a result of falling UV. Mr. Akram's idea relied on the assumption that this enzyme can be synthesized in large numbers, and along with an appropriate electrode can be used in solar panels to set up a current to generate electricity. Thus nature is employed to produce power.

Solving Pakistan's energy crisis:

In Balochistan, Pakistan has a large but low quality deposit of coal, which is almost of no use but for domestic purposes (Read Mehr's blog post on coal reserves in the Thar Desert: "*Black is the color*"). The idea was of setting up a plant in Pakistan, and searching for an appropriate organism that could convert this coal into a much efficient source of fuel such as methane (incidentally, a less environmentally damaging emission than CO2). Although the plan is still in the pipeline, it offers huge possibility of solving Pakistan's crippling energy crisis.

Even though the solar cell may not be 100% effective/efficient, and the idea of harnessing coal energy may not be easy to execute, one can see how we can manipulate bio organisms and biomaterials to solve an abyss of issues concerning our world. Biotechnology may very well be the next big thing for Pakistan.

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[3] http://www.physorg.com/news181849583.html