Program: An Overview of the Nobel Prizes in Chemistry, Physics and Medicine
Speakers: Scientech Club members Dick Carter, Alan Schmidt, and Tom Lauer
Introduced by: Jim Willson ***Attendance:*** 98
Guests: Marvin Miller, Charly Baldwin, Aron Krerowicz
Scribe**:** John Peer
Editor: Carl Warner

Jim Willson proposed today's format suggested by former member Barry Dreikorn who participates in a similar technical club in New Jersey. The idea is to serve our members with a discussion of the importance of Nobel Prize winning discoveries. Nobel winning discoveries often result in significant scientific breakthroughs which have far reaching effects in our everyday lives with insulin and penicillin being prime examples. Each speaker provided a 15 minute discussion of a recent Nobel Prize winning discovery, its relevance, and possible applications. For discussion of Nobel Prizes in general and in layman terms, Jim suggests www.NobelPrize.org

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Dick Carter from Sharpsville earned his Bachelors of Science in Physics plus some Masters courses from Purdue. He enjoyed a 40 year career at Delco in Kokomo where he was involved in a wide range of programs including solar cells, Silicon and Germanium transistors, hybrid microelectronics, electric vehicle power switches, and technology planning. He continues as a consultant with various firms. Dick joined Scientech Club in 2010 and has served on the Board of Directors from 2013 to present.

2014 Nobel Prize in Physics > Isamu Akasaki, Hiroshi Amano, and Shuji Nakamura "for the invention of efficient blue LEDs which has enabled bright and energy-saving white light sources"

LED light is generated when a PN semiconductor junction is excited so electrons change shells around an atom. As the electron drops to a lower energy shell, it releases visible light. This was well developed for red and green LED's, but not for blue. Gallium Nitride was developed as it could generate the shorter wavelength of blue light, but GaN compounds were thought to be too defect sensitive to operate as a PN diode junction. The breakthrough was when Nakamura was able to grow GaN (Gallium Nitride) crystals and then created InGaN/AlGaN blue LEDs (In = Indium; Al = Aluminum).

Another critical problem was having a transparent structure so that emitted light could escape and be useful. In addition, to create white light each LED assembly needed a red, green and blue LEDs in the same structure; a significant engineering problem by itself.

The development of an efficient blue LED has tremendous implications for our modern world. White light is composed of a spectrum of colors, hence the rainbow. However, it can also be created by mixing with three light sources, red, green and blue. Red and green LEDs have been developed for a long time, but the lack of an efficient source of blue light prevented the creation of white light from LED's. To put the importance of LED light in perspective:.

	Lumens/watt	Life (hrs)
LED	300	100000
Fluorescent	70	10000
Incandescent	16	1000

25% of the world's energy is spent on lighting. Hence, LED lighting will significantly reduce worldwide energy use in the long term.

LED lamps show promise to increase the quality of life for the 1.5 billion people without access to a power grid. Due to their low power requirements, portable LED lamps can be powered by cheap solar powered batteries. One such example is the LuminAID created by two graduate students. It can be used anywhere the sun shines. Self-contained solar cells charge the selfcontained battery providing 10 hours of light at night.
https://luminaid.com/collections/solarlights/products/luminaid-packlite-16

Another application is urban hydroponic indoor farming in multistoried buildings: no insects, weather variation, minimal transportation/distribution expense, and multiple crops per year.

Polluted water can be sterilized using ultraviolet LEDs. In other related work, the inventors also developed a blue laser (a sharply focused beam as opposed to the scattered light from an LED). The blue light can store 4x more data than infrared light which in turn, led to the development of Blu-Ray video discs and better laser printers.

Incandescent bulbs lit the 20th century. The 21st century will be lit by LED lamps and related emerging inventions.

Dr. Alan Schmidt is from Michigan where he earned his BSChE from MSU. He earned his PhD from Wisconsin. He did his PhD thesis on polymerization and did industrial research in the same field. He retired in 2014 from the Indiana Department of Environmental Management, Land Quality Engineering. Alan has been a Scientech member since 1999 and served on the Board of Directors 2004-6.

2016 Nobel Prize in Chemistry > Jean-Pierre Sauvage, Sir J. Fraser Stodart, and Bernard L. Feringa "for the design and synthesis of molecular machines"

To introduce this concept, Alan stated a molecular based machine would be 1000 times thinner than a human hair. They were awarded the Noble Prize for "linking molecules together to design everything from a tiny lift to motors and minuscule muscles".

Nobel Laureate Richard Feynman, famed for his 1950's predictions for nanotechnology, supposed in a 1984 lecture that nanometer scale machines were possible and he based his belief on bacterial flagella that moved bacteria. He challenged his audience to do so.

In parallel, chemists were working on molecular chains in which ring-shaped molecules were mechanically linked together. This would be a new type of molecule vs the known covalent bonds in which atoms share electrons.

Progress was slow until 1983 when Sauvage, working in photochemistry, saw similarity to a molecular chain in two molecules intertwined around a central copper ion. His team removed the copper ion and had two interlinked molecules. The copper ion was critical as the efficiency of the reaction increased from a few percent to 42 percent; now it was viable. This, in effect, (re)created the field of topological chemistry. They continued to develop more complex chains. To move on to the concept of a molecular machine, there needed to be movement within the structure. In 1994, Sauvage created a catenane where one ring moved relative to the other when energy was added, the embryo of a molecular machine.

Stoddart, in 1991, built an open ring and an axle. That evolved into a rotazane, a ring shaped molecule on the axle that was movable between electron rich and poor sections. In 1994 he could completely control the movement vs random movement in chemical systems. Since then his group has created a lift capable of moving 0.7nm in height and an artificial muscle.

Producing motors that continually spin in the same direction has been an important goal. In 1999 Feringa produced the first molecular motor. He created a molecule that could spin in only one direction. The molecule was excited by light pulses and spun 180 degrees in the same direction each time. In 2014, the motor rotated at 12M rps (12 million revolutions per second) compared to a car engine of 4K rpm. In 2011 they built a molecular car with four motors serving as wheels; the "car" actually moved.

It is estimated that the molecular motor today is analogous to the electric motors of the 1830's. A similar amount of refinement would truly impact our whole world.

Dr. Tom Lauer is from Ft. Wayne and earned his Bachelors and Masters in Science from Ball State and his PhD from Purdue. He is the George and Francis Ball Distinguished Professor of Biology at Ball State where he has won multiple Outstanding Faculty awards since 2003. Tom joined Scientech in August 2016.

2015 Nobel Prize in Medicine > Youyou Tu "for her discoveries concerning a novel therapy against Malaria"

Malaria, caused by the Plasmodium parasite, is a worldwide disease. 3.2B people (40 percent of the world population) in 106 countries live in areas at risk for malaria transmission. WHO estimates that in 2015 there were 212M clinical episodes and 429K deaths. In the US, malaria was essentially eliminated in the early 1950's. In 1945 it was truly worldwide; by 1970 it was under control in North America, Europe, and Japan. However, in 2015 it was still rampant in the tropical climates of Central and South America, most of Africa, and southern Asia/Indonesia.

Malaria was identified in Roman writings from 2000 BC and was named for *mal* (bad) *aria* (air) from the pungent fumes of swamps. Its most prevalent symptom was recurring fevers. There are five Plasmodium species, the most deadly being falciparum as it leads to encephalopathy. The Anopheles mosquito is the primary host who then transmits it to the human secondary host.

There have been myriad treatments over the 20th century: Quinine, which is produced from the bark of the Cinchona tree, Plasmochin, Atabrine, Resochin (chloroquine), Proguanil, and Pyrimethamine. All were only partially effective and eventually resistance developed. DDT (mid20th century) was very effective at destroying the mosquito population, but it was banned due to its extreme environmental effects made known in 1962 by Rachael Carson's "Silent Spring". By the late 20th century, sulfones and sulfonamides were increasingly effective, but still not a general solution.

Also in the late 20th century, Youyou Tu evaluated traditional/herbal Chinese medicines and discovered that Artemesia annua, sweet wormwood, was effective in treating malaria. Her initial extraction method of hot water and Ethanol was only 10-40% effective in treating malaria in mice. She then discovered that using cold water and ether for Artemisinin extraction provided 100% effectiveness in treating malaria in mice. This is the basis of her Nobel Prize.

Current anti-malarial treatment has evolved to include: 1.) Artemisinin-based Combination Therapy (ACT), 2.) Indoor spraying, and 3) Insecticide treated nets. Artemisinin's benefits to mankind have resulted in a mortality reduction of 50% in last 15 years; no resistance has developed so far.

Tom Lauer, Alan Schmidt, Dick Carter (L to R)