THE LAUREATE LEAGUE

Inside the Awarding of the Nobel Prizes of 2012

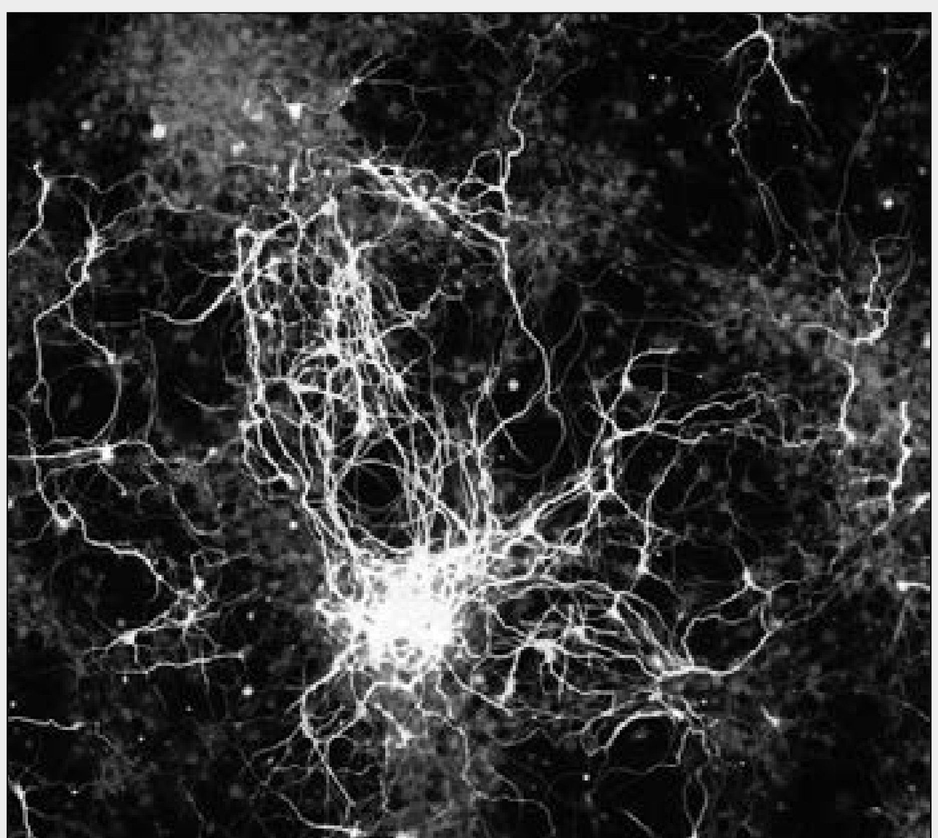
By Fatima Mirza

Few awards in the world exhibit the grandeur of the Nobel Prize. Awarded annually in the scientific realms of medicine, chemistry, and physics, the award truly chronicles the evolution of human intellectuality. Epitomizing the frontier of scientific discovery as vectors for change, the award both encourages and rewards those most passionate about transforming the current ideological landscape. As in years past, scientists bestowed with the honor provided the modern world with breakthroughs that few would rival even when considering the entirety of our history. From directly observable particles to specialized receptors to induced pluripotent stem cells, this year especially marks a year of profound scientific discovery. Unfortunately, even with its widespread notability, few today recognize or comprehend the intellectual leaps of these select individuals. The following excerpts expose the scientifically-curious individual to cutting-edge technologies and ideologies of today while outlining modern applications that make these discoveries not only intellectually but also tangibly satisfying.

MEDICINE

A fetus, a baby, a child, a teenager, an adult, and an elder. We all understand and possess an intimate relationship with the concept of aging. Everyone understands the irreversibility of such a process. But, Nobel Laureates John B. Gurdon and Shinya Yamanaka may have changed all of that (Medicine Press Release).

The two scientists discovered that mature, specialized cells may be reprogrammed to become immature cells. These cells are capable of developing into all tissues on the body. Gurdon discovered in his classical experiment that he could transform a mature intestinal cell into a normal tadpole by placing its nucleus into the egg cell of a frog. This suggested that mature cells retained information to develop into any cell in the body (Gurdon, 1962).



Yamanaka followed this original research with an experiment of his own. He demonstrated that intact mature cells in mice could be reprogrammed to become immature stem cells. After introducing a handful of genes, he reprogrammed the mature cell into an immature cell (Takahashi & Yamanaka, 2006).

By returning mature cells to the stem cell state, these scientists have enabled physicians around the world to master disease pathologies. By comparing diseased cells and reverting them to an immature state, researchers may further analyze the evolution of diseases. Further work may also help turn back the developmental clock of humanity.

Figure 1: Stem cells on the brain can be programmed to become fully mature cells in order to heal damage to the brain. ***Photo by the National Eye Institute.***

CHEMISTRY

As important as observing cells was the determination of their interaction mechanisms. Though we've made great strides in understanding the identity of different cells, much of the underlying chemistry remains a mystery. The most important function of a cell remains that of interacting and sensing the outside world. Each entity acts as a packet of information in its own right; however, without coordination, these never evolve past simple, single-celled organisms.

The underlying beauty of the human anatomical machinery derives solely from the ability of the cell to interact with its surroundings.

Surprisingly, even with its undoubted fundamentality, much of even the simplest of chemical mechanisms remains a mystery; or, so we thought, until the groundbreaking discovery by Robert J. Lefkowitz and Brian K. Kobilka (Chemistry Press Release).

Lefkowitz and Kobilka uncovered the functioning of a family of receptors called G-protein coupled receptors (GPCRs). A broad range of sensors, these GPCRs are receptive to everything from adrenalin, dopamine, serotonin, light, flavor, and odor. Most physiological processes trace back to these chemicals and the responses they induce. Christened the "greatest benefit to mankind", knowledge of these receptors help demystify some of the most complex anatomical processes.

An elusive discovery, the identity and underlying mechanisms of these receptors left scientists baffled. Developing drugs, such as alpha and beta blockers, existed more as a random testing rather than a directed distillation. Even when helping patients, many were unsatisfied because the reason that such drugs affected some cells and not others remained a mystery.

The first breakthrough came in the 1980s when the scientists found the gene for the beta-receptor which responds

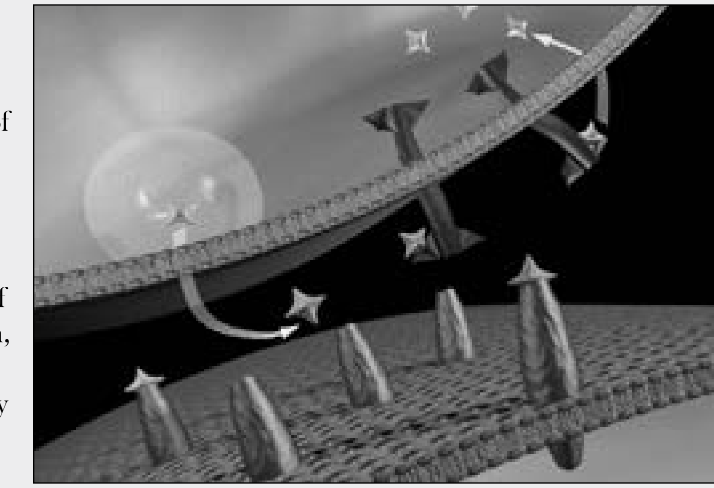


Figure 2: Cell surface receptors play an important role in cellular interaction and sensing the outside world. ***Photo by the National Institute on Drug Abuse.***

to epinephrine and could be the deciding factor between life and death. Analyzing its code, they found that the gene coded for seven helices, or long fatty, spiral strings, that wind back and forth within the cell walls. This was the same number of helices for a light-receptor found in the eye. This was the eureka moment; they concluded that a completely different family of receptors could and did function in the same manner (Williams, 2010).

However, there was still one step left in the puzzle. For the critics, the scientists needed to photograph the existence and function of these receptors. Developing this technology took years, expertise, and a pinch of luck. Finally, in 2011, the scientists published the first image of a receptor at the very moment it transferred signal from the hormone on the outside of the cell to the G-protein on the inside of the cell (Buchen, 2011).

With characterization of these receptors, the scientists have enabled us to understand the fine-tuned regulation of cells that life requires.

PHYSICS

Imagine studying something without possessing the ability to directly observe it even through the most sophisticated of modern technologies. The major conundrum in the 17th century involved cells. Before Leeuwenhoek constructed the first microscope to confirm their existence , scientists explicated these entities only through inference. His technological breakthrough allowed us to reside on the scale of scientific thought we enjoy today. If cells are the experimental subjects of biology, physics exhibits a parallel relationship with particles. Until recently, a scientist only ventured guesses regarding quantum mechanical theories through though experiments. The entire paradigm underlying this field involved agitating these particles to an extent where they may possibly manifest bizarre phenomena that support hypotheses. We possessed the ability to understand larger scale interests such as the laws of classical physics. However, as we transition into the realm of atomic proportions, these laws cease to exist; rather, we enter the domain of quantum mechanics.

Nobel Laureates, Serge Haroche and David J. Wineland, independently developed the methods for isolating individual particles while preserving their quantum mechanical properties such as spin and charge. This groundbreaking feat enables physicists to begin directly observing those bizarre phenomena from the past for the first time (Physics Press Release).

The invention of methods was no small achievement. It involved highly specialized materials that pushed the limits of purity. As the scientists developed the technologies independently, they ended with similar yet distinct methodologies. Wineland trapped electrically charged particles and ions within an electric field; in order to ensure maintainence of quantum-mechanical properties, he also subjected the particles to extremely low temperatures within a vacuum. Using laser beams, Wineland suppressed the ion's thermal motion, allowing it to occupy two different energy levels simultaneously. Haroche, on the other hand, allowed photons to bounce back and forth between two of the world's shiniest mirrors made of superconducting materials cooled to a temperature just above absolute zero. These forced the photons to bounce back and forth for almost a tenth-of-a-second, the longest recorded lifetime.

These methodologies enable scientists to tackle one of the most interesting, outstanding questions in modern physics. Schrödinger's cat, described as a thought experiment by Nobel Laureate Erwin Schrödinger, existed in a box in superposition where it is both dead and alive. However, once we venture to peek into the box, the cat immediately collapses into one of two states, either dead or alive (Yam, 1997). This parallels our modern world, which involves both the micro-scale quantum system and macro-scale classical physics. Wineland and Haroche's breakthroughs allow us to maintain the cat in a state of superposition so that we may observe and document its activity.This occurs because their new technologies forces the particle into an intermediary state where it exists as neither one nor the other.

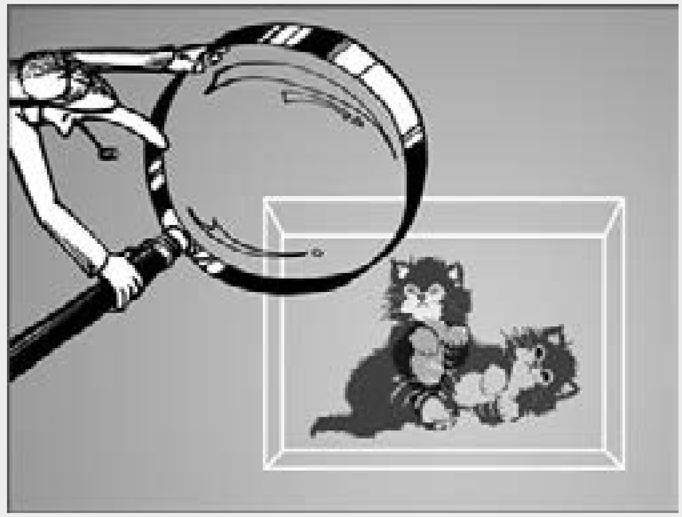


Figure 3: Schrodinger's cat has been a major concept in physics, and a subject of heated debate for decades. ***Photo by the Lawrence Berkeley National Lab.***

Beyond academic physics, these advancements also possess the potential to involve extremely practical applications in both computers and clocks. By definitely demonstrating that a particle may maintain two positions at the same time, the scientists suggest that the same concept may be applicable to the basic unit of information in computers. This ability to hold two values simultaneously would increase the speed exponentially. Another practical use of these findings are optical clocks, which trap ions to measure time a hundred times more precise than cesium-based atomic clocks (Monroe & Wineland, 2008).

Advancing Humanity

2012 marks a year of true innovation. The Nobel Laureates in physics, chemistry, and medicine introduced technologies and made discoveries that have the potential to change the course of humanity. From isolating quantum particles for creating the world's fastest supercomputer to engineering our own cells to combat disease, the possibilities are endless. However, these advances will only effect positive change in an educated and receptive society. The first step is understanding these scientific breakthroughs; the next is pioneering our own destiny.

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