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Top 7 science and medicine trends for 2015

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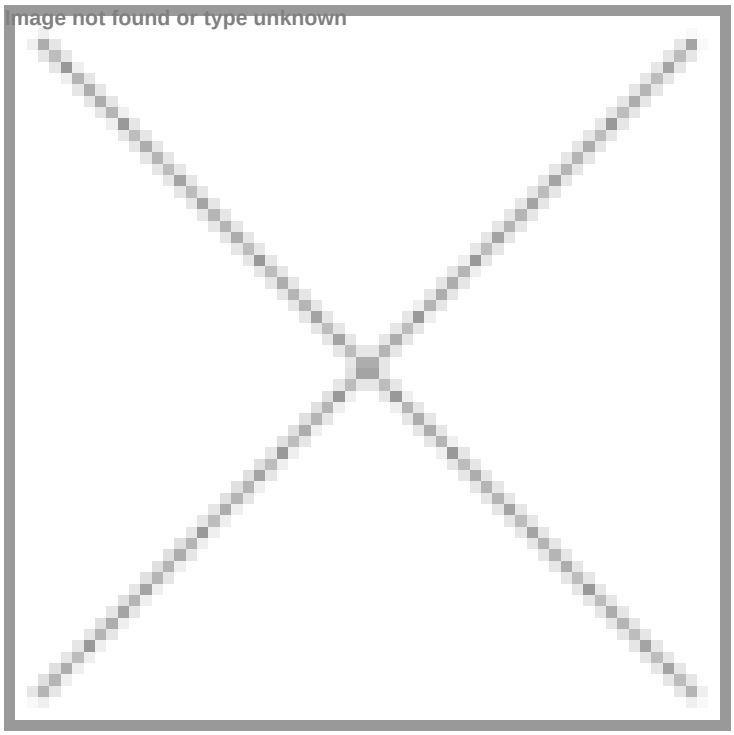

The health sciences are constantly pushing toward more effective treatments and cure. The question is: where will we see the next breakthroughs? These range from basic science to digital health, from aging research to cancer treatments, and from approaches in the lab to access at the hospital

1. Hacking the brain

Significant and technological advances are ushering in an era that would have been unimaginable to early brain scientists. Long lasting implants employing hundreds or thousands of electrodes can be placed in the brain to both deliver stimulation and to 'listen to brain activity for signs of trouble.

"Powerful new tools allow researchers to monitor activity patterns across brain circuits, bringing us closer to understanding how perception, thought and action arise from different circuits," said Phillip Sabes, PhD, professor of Physiology.

Eventually, Professor Sabes said this technology will allow amputees and patients with paralysis to directly control artificial limbs with brain signals, will predict and head off epileptic seizures, and will better treat Parkinson's disease and other movement disorders.

In addition, UCSF scientists are exploring the possibility that brain implants could ease the symptoms of - and perhaps even

cure - psychiatric disorders including anxiety, depression, and addiction.

2. Breakthroughs in Teamwork

Scientists are embracing a multidisciplinary team effort to make the most increasingly powerful and opens up new complex ways to tackle problems. This is in stark contrast to the competitive nature of rival scientific labs of the past to be first out of the gate with important findings.

Take genomic research, for example. Since increased risk for many diseases may reside in very rare, difficult-to-find mutations, many researchers have begun assembling large international research groups to freely share data.

"One of the major drivers of recent progress has been a wholesale shift in culture. Investigators who were once fierce competitors are now finding ways to collaborate with one another in large-scale, multi-site genomic studies," said Matthew State, MD, PhD, chair of Psychiatry.

Two recent collaborative studies of the genetics of autism involved 50 laboratories worldwide and uncovered more than 100 genes linked to the risk of autism. Before this work, smaller efforts had identified only 11 genes that confer a risk for autism.

Nothing succeeds like success, so expect to see more "shared science" in the coming years.

3. Diagnosing Disease through DNA

"Next-generation DNA sequencing" allow lab workers to read out the equivalent of an entire genome's worth of sequence in a day DNA - for less than $1,000. Now this technology has begun to be used as diagnostic tools.

Next-generation sequencing offers unprecedented throughput, scalability and speed that could have untold impacts on studying disease, biology and clinical research, said Charles Chiu, PhD, director of UCSF Viral Diagnostics and Discovery Center.

"We are gradually moving away from using next-generation sequencing exclusively as a powerful research tool and we are starting to use it in the clinic," said Dr. Chiu.

His team used the technology to identify the cause of life-threatening meningitis within 24 hours, saving the life of a 14-year-old boy after all standard diagnostic tools failed. After sequencing all the DNA found in his spinal fluid, from the patient's own DNA to bacteria and viral DNA, scientists were able to identify the culprit as an unusual, but easily treated bacterial infection.

Dr. Chiu is now working on applying this technology to develop a rapid diagnostic test for the Ebola virus.

4. Rejuvenation through the Blood

Sound straight out of a vampire novel? Well, a recent study led by Saul Villeda, PhD found that infusions of young blood can perk up the brains of older mice. The Sandler Faculty Fellow made front-page news with these findings when his team identified evidence of cognitive improvements in the old mice after they were connected to the circulatory systems of younger mice.

At the same time, a team at Stanford University found that young blood could help rejuvenate heart muscle, too. In fact, young blood seems to improve muscle, liver, heart and brain - discoveries that have spurred a quest for the specific molecules responsible for rejuvenation.

"Today it seems as if everyone is going after molecules in the blood that might help reverse biological aging. There also are factors that can be removed from old blood to slow aging, and we want to explore these, too," said Dr. Villeda. As the search continues, he and his collaborators already have launched a small clinical trial to test young blood in Alzheimer's disease.

5. Prime Time for Telemedicine

Telemedicine is finding its place in modern medicine, especially in American health care, according to Seth Bokser, MD, MPH, to allow experts to consult remotely via virtual office visits, radiological readings and even remote ICU monitoring.

"Telehealth is the right technology for our times. Americans want high quality, personalized care. Providers and patients alike

are beginning to trust information technology with their health," said Dr. Bokser, medical director for IT at UCSF Benioff Children's Hospital.

Additionally, as primary care doctors are retiring, rural areas are struggling more than ever, and community hospitals need cost-effective ways of providing both primary and specialty care.

While nothing can replace an in-person visit, t, especially when patients are experiencing new symptoms, telemedicine is finally coming into its own.

6. Breaking Down Cancer Categories

Genome-sequencing technology now has broken down cancer as a diverse collection of diseases demanding a wide range and combination of treatments.. Today's powerful sequencing technology is allowing scientists to examine tumors letter by genetic letter, with surprising results.In 2014, a study partly led by UCSF scientists suggested that these new techniques could lead to more accurate diagnoses for as many as one in 10 patients.

"For the first time ever, we're able to pinpoint to important molecular features shared by cancers that affect different tissues. This will have huge implications for therapy as we begin to design treatment plans based on a cancer's molecular signature," said Denise Wolf, PhD, computational biologist at UCSF Helen Diller Comprehensive Cancer Center.

Combined with decades' worth of accumulated clinical experience, such insights are already leading to radical new treatment recommendations.

7. Systems Pharmacology

Molecular biology transformed the field of pharmacology by allowing researchers to isolate and purify the particular receptors through which drugs acted. Yet 30 years after first focusing drug research on the molecular level, fewer drugs have since been discovered - and at greater expense.

To spur drug development, many researchers say the focus needs to be on both molecular and systemic impacts. This emerging field, known as systems pharmacology, integrates the behavior of molecules to understand the effects of drugs on the whole organism.

"Scientists can now design molecules with exquisite potency and specificity for particular receptors, and by combining this knowledge with our understanding of whole body systems, there's huge potential for a rebirth of pharmacology," said Brian Shoichet, PhD, professor of Pharmaceutical Chemistry.

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