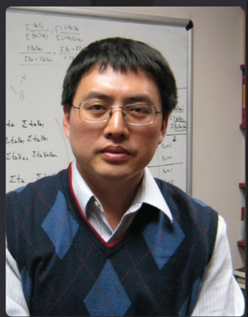
RESEARCH ROUNDTABLE

AGE OF TECHNOLOGY

Medicine is a field that is characterised by technological innovation. A constantly changing healthcare environment means that the tools researchers and medics have at their disposal must be as novel and ingenious as the diseases they are attempting to control. We are living in particularly exciting times, as new molecular and computational technologies, as well as the advent of personalised medicine, look set to revolutionise healthcare

What technological breakthroughs have facilitated your research and what potential advances do you foresee in the future? How will this impact healthcare in terms of research and treatment?



Professor Hongyu Zhao (Yale University Computational Biology & Bioinformatics):

My research has been largely driven by high-throughput technologies that are capable of surveying biological systems at the genome level. For example, microarray genotyping arrays allow researchers to simultaneously collect genotype information at millions of sites in the genome, for thousands of study subjects. These data can be used to study correlations between these sites and disease phenotypes, such as cancer and obesity, to identify genomic regions affecting disease risk. With next generation sequencing technologies, the field is undergoing another revolution because we are analysing all three billion bases. This creates computational and statistical challenges that are totally unprecedented in the medical world.

Dr Laurent Groc (Interdisciplinary Institute for NeuroScience):

We have demonstrated that stress and antidepressant drugs actually regulate the surface dynamics of glutamate receptors, altering the plastic range of synapses and consequently affecting cognitive function. In addition, we recently discovered that neuropsychiatric disorders are solely dependent on altered glutamate receptor surface dynamics. If the physiological understanding of receptor dynamics is still in its infancy, then the clinical consequences are virtually non-existent, but several highly promising new avenues of clinical research have been opened.

Dr Hinrich Habeck (Life Science Nord):

Personalised medicine will be the major driver for healthcare innovation in the coming years. Improved sequencing, computing and imaging will all help to identify biomarkers that can be used as companion diagnostics for therapeutics. In addition, I am sure that medical devices such as implants will also be individually tailored in the future.

Dr Marcel Tilanus (University Hospital Maastricht):

We introduced the sequence-based typing approach in 1990, believing that it would work, and now it is standard practice. The next step is to define single-nucleotide polymorphism (SNP) diversity for all genes in the human leukocyte antigen region, and genes related to immune responses. I envisage nanotechnology approaches being refined and applied to routine diagnostics in the near future.

Dr Laurent Cognet (Interdisciplinary Institute for NeuroScience):

The main technological breakthroughs of the past 15 years for single molecule detection have been high quality charge-coupled device cameras with single photon sensitivity and ultra-low noise capabilities, and also the synthesis of a variety of elegant nano-objects. Many nano-objects are now synthesised in reproducible manner with unique optical properties; these include metal nanoparticles, semiconductor nanocrystals and carbon nanotubes.

Professor Shuajp Kraja (International Institute of Biotechnology):

Molecular biology is benefiting a lot from today's technological breakthroughs, owing to new devices that make it possible to penetrate the cell's molecular substructure, turning this field into more of an experimental science. Submolecular penetration will ultimately make it possible to identify, analyse and explain all genetic and molecular organic anomalies, providing us with the opportunity to examine their origins and learn to fight them.

Dr Taran Skjerdal (STARTEC):

The microwave oven has made it possible for consumers to get good, healthy food even if they are not able to cook. Full meals for microwave heating have probably reduced the need for healthcare institutions, as more people can stay at home longer than they would be able to if they had to do all cooking themselves.

Dr Arnoud Boutin (Leibniz-Institut für Arbeitsforschung):

The development and use of new equipment and techniques (magnetic resonance imaging, electroencephalography, transcranial magnetic stimulation, near-infrared spectroscopy, etc.) has deepened our understanding of human cognition and memory. The intertwined relationship between fundamental and applied research should yield theoretical breakthroughs and healthcare innovations, such as designing innovative rehabilitation or treatment protocols.

Dr Walter Langel (Institute of Biochemistry, University of Greifswald):

For molecular modelling, the main technological breakthroughs are found in computer science. In chemistry, computers are used for number crunching and any increase in computing power allows the maximum model size and simulated time to grow. Development will move away from the calculation of single examples of simplified systems, for the mere demonstration of effects and evaluation algorithms – as computers get faster, it becomes more feasible to handle specific systems in complex biochemical environments. Crucially, enhanced computer power helps to vary parameters and simulate systems with various starting conditions. In addition, answers to specific biochemical questions and experimental results will be obtained more rapidly.

Dr Attilio Di Pietro (Université Lyon):

There have been two main breakthroughs in our field: first, the rational optimisation of ABCG2-selective inhibitors by characterising their molecular mechanism. This allows for the obtention of lead compounds which are potent, selective, non-toxic, non-transportable and able to either block the transporter conformation (preventing changes required for drug transport) or uncouple ATP hydrolysis and drug efflux (dissipating produced energy). This has allowed us to find drug candidates which are active in our mice models *in vivo*.

The second innovation is the establishment of the 'Achilles heel' concept for resistant cancer cells overexpressing multidrug ABC transporters to catalyse an extensive efflux of chemotherapeutics. This may result in new, specific targets for cytotoxic compounds being displayed, which behave as new anticancer agents targeting and eliminating resistant cancer cells.

Dr Scott Pavey (Institute of Integrative Biology and Systems, Medicine Laval University Quebec):

High-throughput sequencing technologies have opened the door to my current research. Many researchers are hoping to soon witness long, high quality genome sequences so that many short reads can be assembled into chromosomes. Once many genomes are properly assembled and annotated, I believe that studying the ecology and evolution of immune system genes in diverse organisms will allow health researchers to develop new treatments that will benefit humans. For example, in the recent draft genome of Atlantic cod, researchers found that a gene named MHCII, one of the two primary immune system genes, was completely disabled. Usually, this gene is responsible for recognising bacterial infections and initiating an immune response. However, a closely related gene known as MHCI, which is usually only responsible for viral response initiation, had duplicated within the genome and diversified to fill the role of MHCII. When scientists see more genes like this, which do not 'follow the rules', it may give them new ideas for experiments or drug development.