



Whats New in Medicine 2015 and beyond!

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The Micro

1. Nanotechnology
2. Tumour therapy – changing landscape : kinases , local delivery, modulating the immune system
3. Tissue regeneration and stem cell therapy
4. 3D printing
5. Genomics
6. Gut biotome

The Macro

1. What Apple Google and Microsoft are doing – apps, research Watson
2. Crowd sourcing and cloud



The Micro View

“Specific technologies”



- Nanotechnology is the science, engineering, and technology conducted at the nanoscale, which is about 1 to 100 nanometers
- “Nano-medicine” explores the interaction between nanoparticles and cells
- One nanometer is one “billionth” of a meter



Drugs may be targeted to tumours by:

- attaching proteins that bind to receptors expressed only by tumour cells
- by designing them to release their cargo in the biochemical environment of the tumour e.g. acidic environment .

Creation of imaging agents that only produce signal from diseased tissues

“Theranostics”- deliver a radionucleotide or magnetic field inside a nanoparticle with a high selectivity for cancer cells- the same nanoparticle can deliver a drug to kill the tumour



- Kinases
 - family of molecules that can signal proteins to direct the way a cell grows and develops
 - most mutated molecules found in cancers (of all types)
 - More than 518 individual kinases are known to make up the human “kinome”
- A number of research trials are looking at identifying kinase aberrations in tumours e.g. poor prognosis disease such as pancreatic cancer, triple negative breast cancers etc.
- One example – CGL -synthetic molecules that inhibit the kinase Bcr-Abl have revolutionised survival and increased 5 year survival by 25% -100%
- May lead to a different framework of cancer identification : a kinase based approach rather than an anatomic approach



Immunotherapy has transformed survival in some patients with metastatic melanoma

Ipilimumab (**Yervoy**) stimulates T cells by inhibiting a regulating cell surface molecule which prolongs survival and 20-30% surviving 3 years

Trial agent Pembrolizumab (formerly MK-3475 and lambrolizumab, trade name **Keytruda**)-
new agent with complete remission documented in some with stage 4 melanoma



- Metastatic melanoma and gene therapy
 - Chemotherapy - disappointing
 - 50 % of melanomas have a mutated BRAF oncogene
 - 2 orally administered inhibitors of BRAF (which act on the kinase pathway) significantly prolong disease free progression and survival



Tissue engineering: replacement tissues and organs are produced outside the body-
combined with "nano- scaffolding " 3D printing



- What can be printed? Probably anything
- Teeth
- Hip or other joints
- Prosthetics- heart valves
- In addition to metals and plastics, doctors and scientists around the country are loading 3-D printers with human cells and printing living tissue, called bioprinting.
- The Holy Grail is to print a living organ for transplant using a patient's own cells



- The study of organism entre genetic makeup and its interaction with environment or non – genetic factors
- Recent advances
 - NEJM March 2014- cells can be engineered genetically to make them resistant to HIV
 - Diagnosing rare genetic diseases
 - 5,000 rare genetic diseases identified already
 - \$400 million research program, the Centers for Mendelian Genomics-investigating the remaining 2,000–4,000



- Not yet – but getting there
- Organovo, for instance, created a mini human liver that actually works - except it lasts only 40 days.
- University of Louisville April 2014 successfully printed heart valves and small veins
- Mid 2014, researchers from Sydney and Harvard universities managed to 3D bio-print capillaries :
 - fabricated tiny, interconnected fibres to serve as the mould
 - covered the structure with a **cell-rich** protein-based material
 - removed the bio-printed fibres to leave behind a network of tiny capillaries coated with human endothelial cells, which formed stable blood capillaries in less than a week.
- Biomedical engineer and a leader of the research, the University of Sydney's Dr Luiz Bertassoni, said printing organs may still be a couple of decades away, but this was a "great step" towards achieving that goal.



- For every human cell , we carry 10 gut microbes
- Human gut microbiota has 3.3 million genes vs 23 thousand genes present in the human genome (Genomic medicine is VERY interested in this)
- Increasing evidence of involvement in disease:
 - Autism
 - Schizophrenia
 - Irritable and inflammatory bowel disease
 - CRC
 - Obesity / metabolic syndrome
 - Liver disease (NAFLD, cirrhosis , encephalopathy)
 - Immune mediated diseases



The Macro

The big players



- Disrupters:
 - Netflix - the video industry
 - Uber -the transport industry
 - Apple, Google, Microsoft, and Samsung are looking to disrupt the health care industry
- Why?
 - computers, sensors, robotics and artificial intelligence are advancing at exponential rate



- Artificial intelligence–based apps will
 - constantly monitor our health data
 - Give us early warnings at first sign of disease
 - advise us on interventions e.g. medications, lifestyle and habits
- Example Google is developing a contact lens that will measure blood sugar levels in tears
- Google is developing cancer detecting –notified by a wearable wrist computer
- Google and Amazon offer a repository for DNA information

The big players



- Apple –**ResearchKit** (March 2015)
- Open source platform + app builders + institutions to capture and upload data from volunteer patients who have a particular disease.



- IBM looks for Super challenges in computing - e.g. Deep Blue beat Garry Kasparov in chess
- Jeopardy was the focus : 2011 , 2 of the most successful Jeopardy players ever were beaten
- Thanks to its computing power Watson can sift through 1.5 million patient records and histories to provide treatment options in a matter of seconds based on previous treatment outcomes and patient histories.
- It has been fed with more than 600,000 pieces of medical evidence, 2 million pages of text from 42 medical journals and clinical trials in the area of oncology research
- Columbia University Medical Centre and University of Maryland School of Medicine are participating in the clinical use of Watson



- Earlier diagnoses
- Better individual risk profiling - genomics, behaviour
- Change in disease definitions e.g. cellular v organ
- Increased survival for diseases
- Less toxicities for therapies e.g. chemotherapy
- Insurance medical examinations may take place in a booth / virtual visit
- Stress / depression with biomarkers e.g. galvanic skin responses, HR variability
- With cellular or very early diagnoses? No need for insurance
 - Precedent - Google driverless cars will disrupt the auto insurance industry



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