

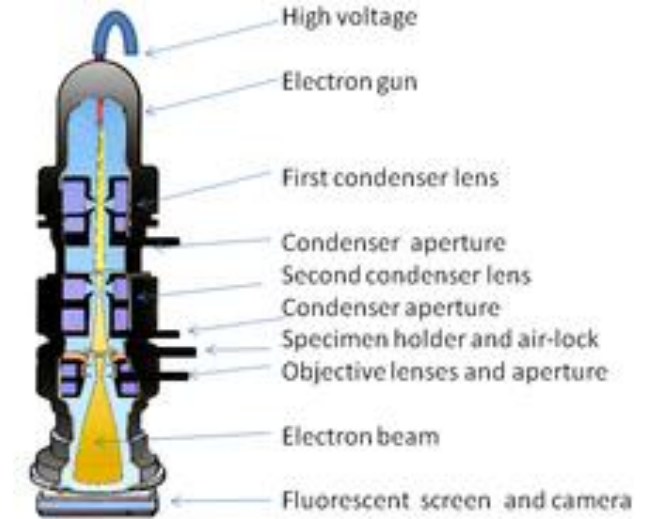
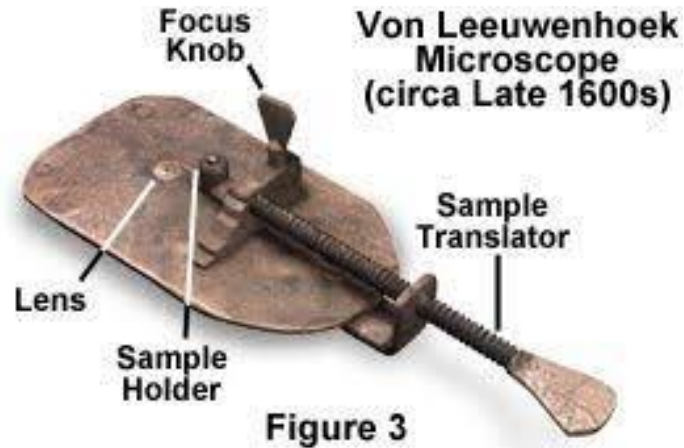
The Future of the Microscopic World

CTYI, DCU

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If you have any questions
about anything – email me at
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So we've covered a lot over the last few weeks

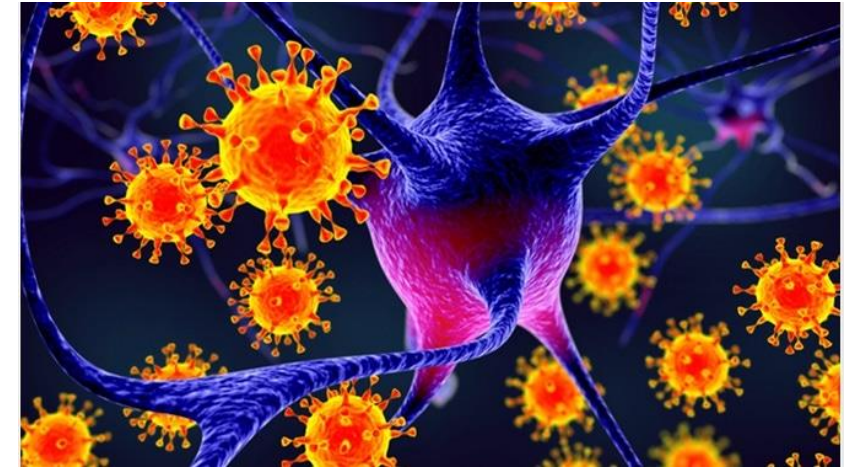
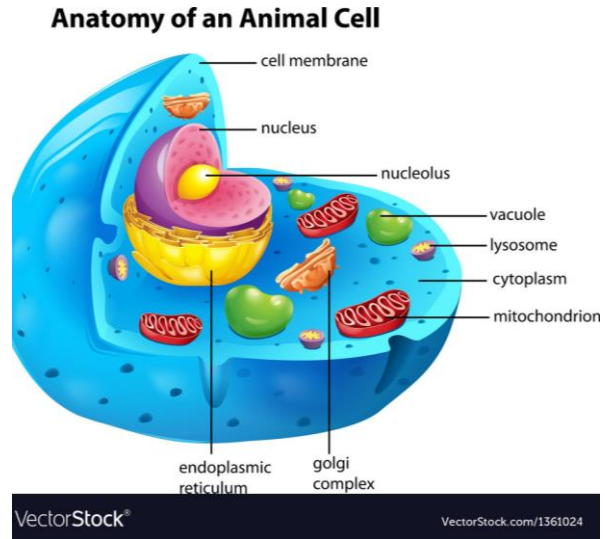
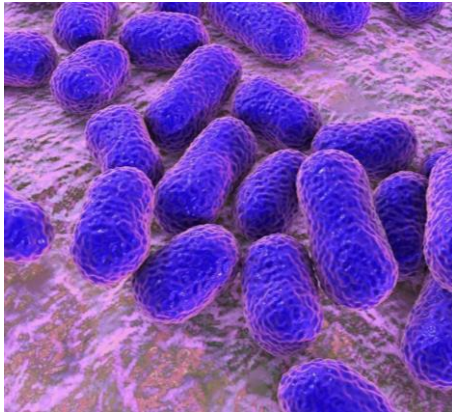


We've talked all about the different reasons we use microscopes
For forensic science, for medicine,
for archaeology and of course for
science

We've also talked about the history
of microscopes and how they were
developed
We've learnt how microscopes work,
how to use them and looked at some
things underneath them

We've looked at the different types
of microscopes – transmission
electron microscope, scanning
electron microscope,
immunofluorescence, tunnelling
electron microscopes

So we've covered a lot over the last few weeks



We've learnt about bacteria, their structure, how they make copies of themselves, what they look like, their role in health and disease and we tested if soap and water, hand sanitiser more effective at getting rid of bacteria

We've talked about the structure and function of animal cells and looked at animal cells under the microscope

We've discussed all about viruses, what they look like, how they replicate and all about Sars-Co-V2 and COVID-19

So we've covered a lot over the last few weeks



We've talked about the immune system, the different types of cells, the innate and adaptive immune system and how vaccinations work



We've learnt about genetics, how DNA was discovered and its structure



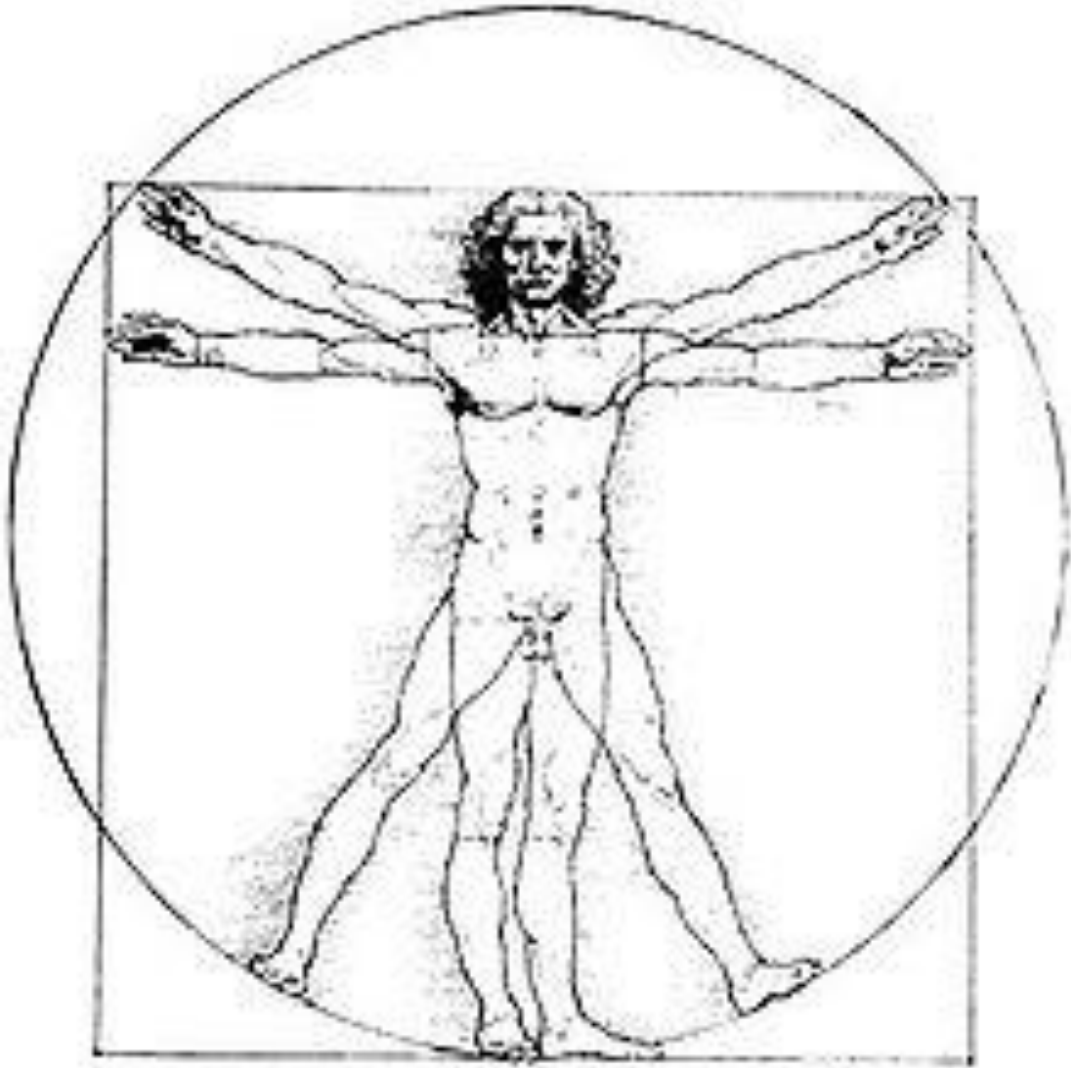
We've discussed all the brain, its structure, how neurons work and made a model of neurons

So today we're talking about the future

- This is a really exciting area of science to be involved in
- Huge advances happening in computers, microscopes, medicine
- A lot of work happening in Ireland
- Majority of large biotech and pharmaceutical companies have a base in Ireland – 24/25 biggest companies in biotechnology are in Ireland
- Really exciting work happening in colleges and universities



Human genome project



- Genome = the complete set of genes or genetic material present in a cell or organism
- In 1990 scientists began working on the Human Genome project
- The aim of the project was to find out the precise sequence of bases A,C,G, and T in the DNA molecules that make up the human genome and to make a map of which genes can be found where

Human Genome Project

- First step – was to make ‘maps’ of the chromosomes so we could pinpoint the location of certain genes
- But the real key step was sequencing DNA
- Cut DNA into smaller pieces of different lengths
- These DNA sections were read by a computer than looks for patterns and puts the DNA back together
- This project began in 1990 and was very slow, and time consuming but as we learnt more about DNA sequencing, made new machines and got more powerful computers
- <https://www.youtube.com/watch?v=MvuYATh7Y74>

What did the HGP achieve?

Human genome project took 13 years and cost 5 billion dollars – what did we learn from it?

It showed that our genome has 3200 million base pairs but only about 25,000 genes

Most of our DNA doesn't actually code for proteins!!

Junk DNA???

HGP showed that humans are 99.9% identical but differ by 0.1%

These changes are in these non-coding sections of DNA

Sequencing DNA



Quicker, cheaper and faster than every before



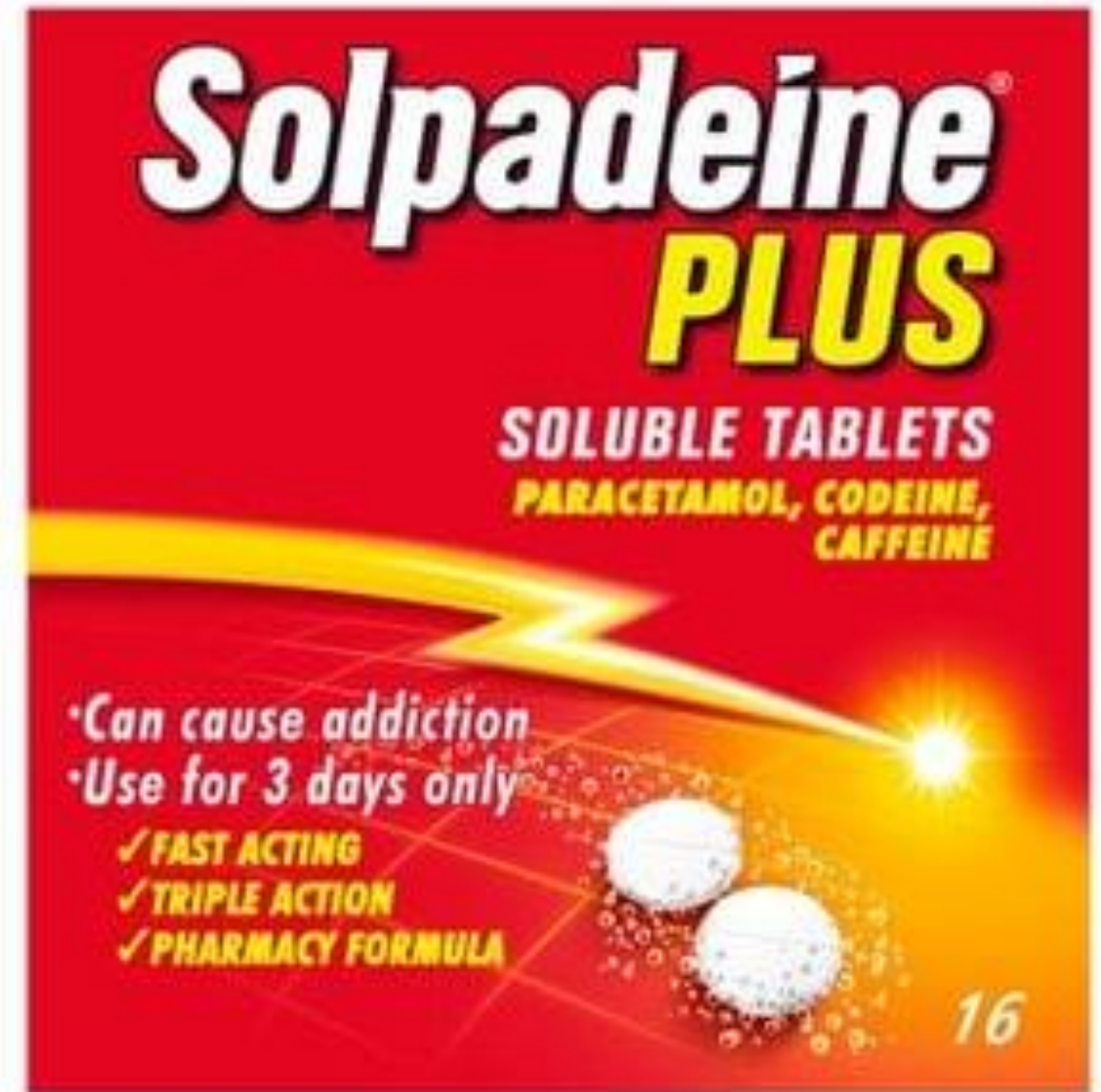
Personalised medicine



Your doctor would know your DNA, know your disease and prescribe exactly the right type of medicine to treat you

Personalised Medicine

- At the moment, we treat everyone with a 1 size fits all approach
- Codeine is a painkiller used to treat mild to moderate pain
- It gets broken down in the Liver and converted to morphine by the gene *CYP2D6*
- If you have a mutation in this gene, codeine will not give you effective pain relief



Era of personalised medicine

- If your doctors knew your genome they may be able to help a lot more
- They could know what drugs work better for you
- They could predict our individual risk of developing disease
- Detect illness earlier;
- Determine the most effective interventions to help improve our health, be they medicines, lifestyle choices, or even simple changes in diet



But is there a catch?



Much of our genome remains a mystery



One gene generally doesn't cause a disease – several of them working together do and often the environment also plays a role



It is still very expensive to do for all patients for the benefit it would give us right now



Lots of ethical issues surround it – do we have a right to ignore, privacy, discrimination, who owns the data

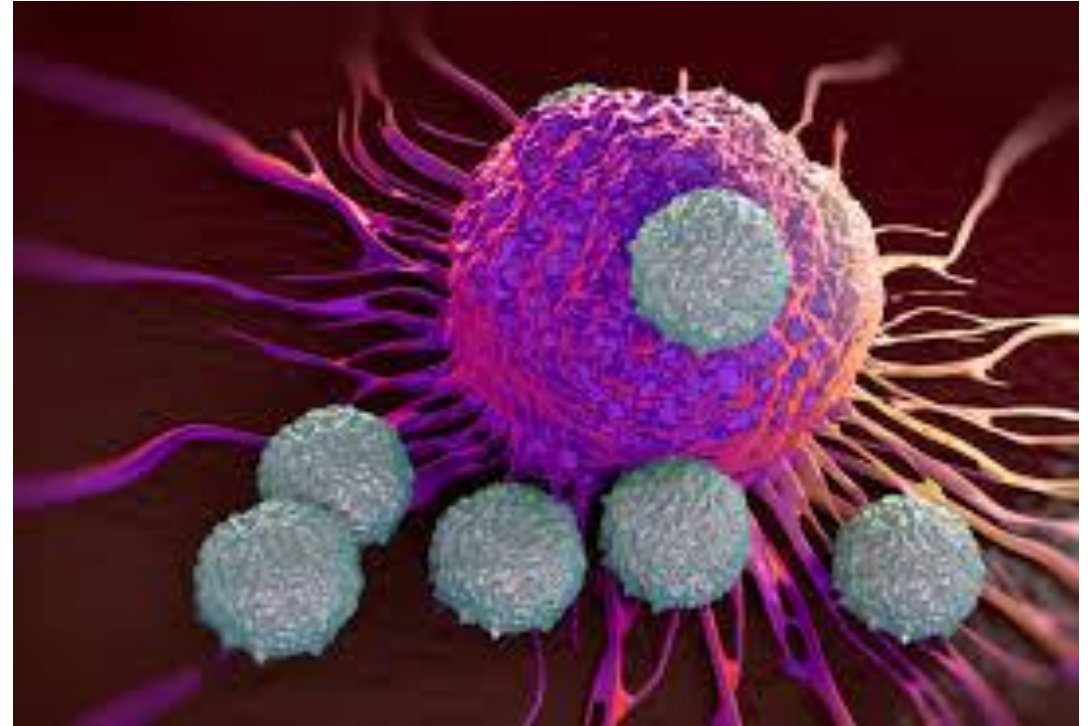
Private genetic testing



- Lots of companies now offer this – ancestry.com, 23andme
- Not medically relevant. False sense of security
- Genetic testing needs to be done with a doctor and a genetic counsellor
- Privacy issues – Insurance, giving away not just your own information,
- Lots of people use for tracing family trees and can encourage people to look after their health

Immunotherapy

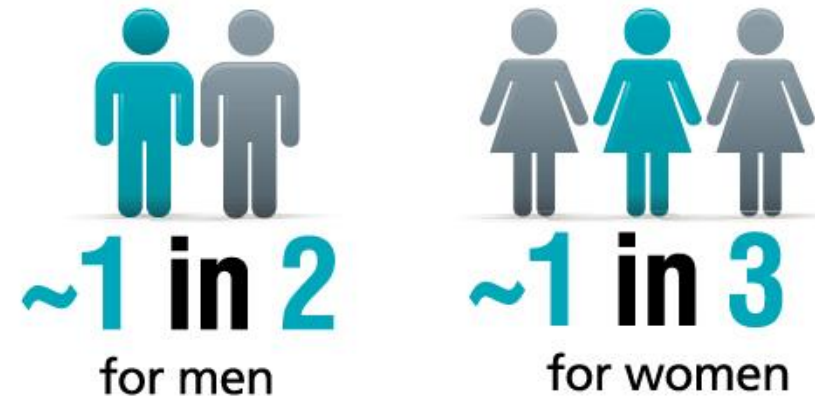
- Immunotherapy is the hot topic in biology right now
- The immune system is our body's defence against pathogens
- But it may also play a very important role in preventing and getting rid of cancer
- Two immunotherapy researchers won the Nobel Prize in Physiology or Medicine in 2018 - James P. Allison, PhD, of The University of Texas MD Anderson Cancer Center, and Dr. Tasuku Honjo of Kyoto University in Japan.



What is Cancer?

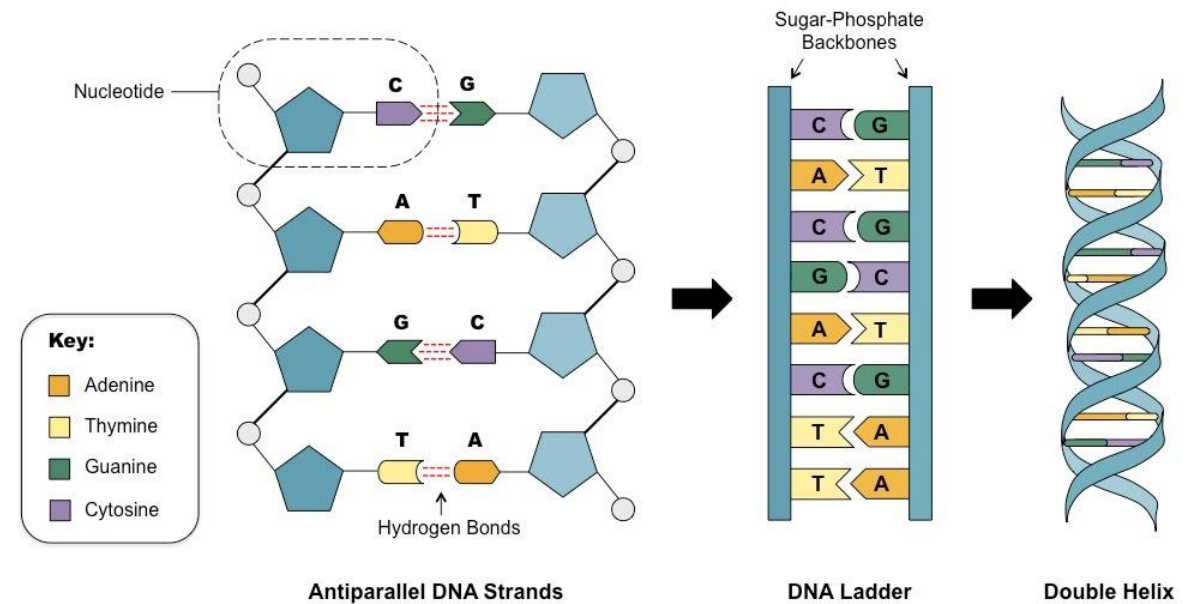
- Cancer is a disease that is caused by cells dividing rapidly and not dying off as they are supposed to
- 1 in 3 people will develop cancer in their lifetime
- **This year in Ireland an estimated 43,361 people will be diagnosed with cancer.**
- Incidence continues to increase but also the survivorship

LIFETIME CHANCE OF
GETTING **CANCER**: (Howlader et. al 2013)



DNA mutations

- Your DNA needs to make copies of itself
- Your cells are quite accurate at replicating the DNA but they do make mistakes
- Your cells can go back and fix mistakes but it's still not perfect
- Angelina Jolie and BRCA mutation
- A buildup of mutations can eventually lead to cancer

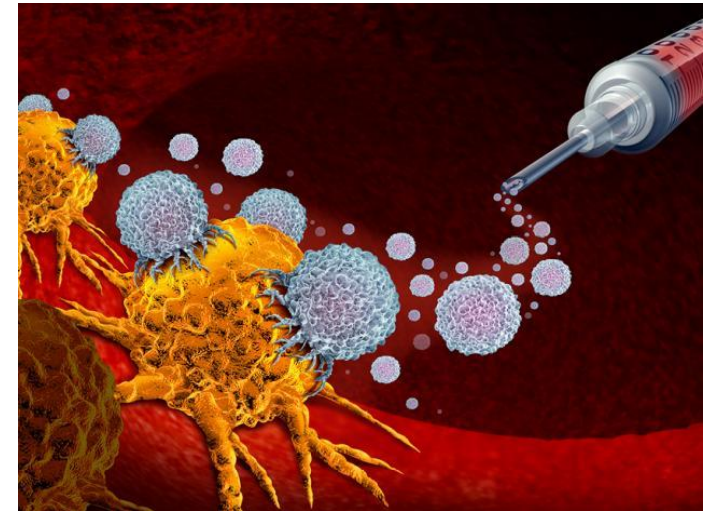


Cancer and the Immune system

- Even though 1 in 3 people will develop cancer, it's surprising more people don't develop cancer
- We now think cells that could become dangerous occur more frequently than we thought but your immune system recognises them as dangerous and kills them
- So when cancer arises, this usually means our immune system is working the way it should
- Our current strategy to use surgery, chemotherapy or radiation to kill cancer cells but these are incredibly toxic and dangerous to the body
- Idea – what if we could switch back on the immune system so our own cells can fight the cancer

How do immunotherapies work?

- <https://www.youtube.com/watch?v=CwaMZCu4kpl>
- Note: APCs in the video above are another name for the dendritic cells that we talked about when we discussed the immune system
- <https://www.youtube.com/watch?v=jDdL2bMQXfE>
- Immunotherapies are beginning to be used to treat cancer but often only at late stage cancers and only certain types of cancers. Really expensive
- It sometimes works and it sometimes doesn't and we're not sure why
- Often quite severe side effects
- Cancers can overcome immunotherapy and become resistant



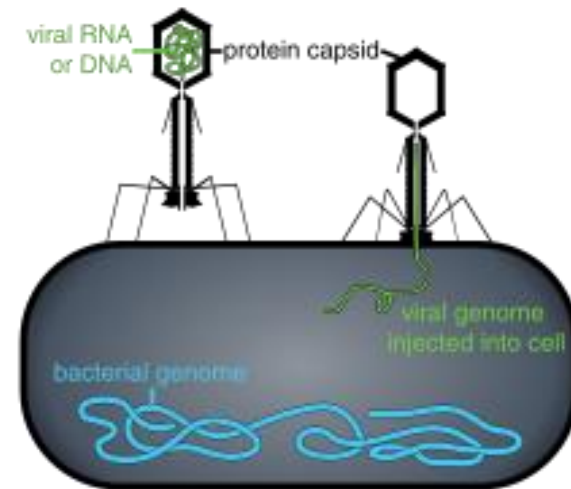
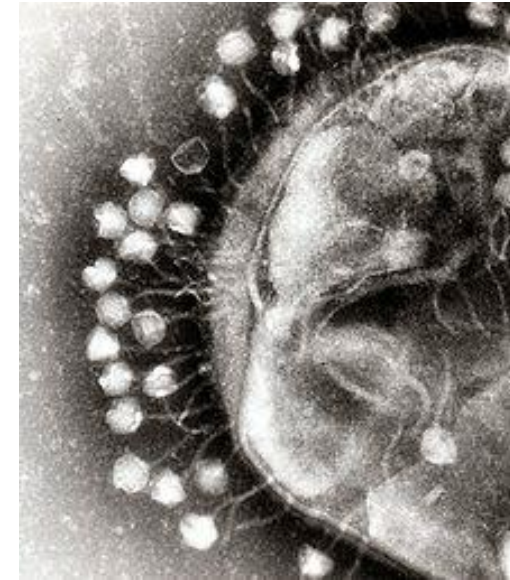
Nanomedicine

- In 1959, Richard Feynman made the famous assertion that one day we will be able to swallow the surgeon
- <http://payteOA5VDRI://www.youtube.com/watch?v=>
- Could take images of inside of the body without invasive cameras
- Or could deliver drugs straight to the area of disease and reduce side effects
- Really in-depth video if you are interested - <https://www.youtube.com/watch?v=Cg--UVL9xCc>



Cure to antibiotic resistance

- Antibiotic resistance is a growing issue
- Bacteria can mutate so they are no longer effected by an antibiotic
- Means killing them is more difficult and eventually we might not be able to
- MRSA (Methicillin-resistant Staphylococcus aureus) and Multi- Drug Resistant TB
- There are viruses that only target bacteria – bacteriophages
- The viral genome effectively replaces the bacterial genome, halting the bacterial infection. The bacterial cell causing the infection is unable to reproduce, and instead produces additional phages.
- Advantages include reduced side-effects and reduced risk of the bacterial developing resistance. Don't harm our microbiome too
- Disadvantages include the difficulty of finding an effective phage for a particular infection. Phages are very selective in the strains of bacteria they are effective against.



Thank you!

- There is a quiz attached. Try to see how much you can remember from the last couple of weeks
- Any questions or queries, just send me an email - niamh.kerslake.staff@ctyi.org