

Genome Academy: DNA to Data

22nd – 24th August 2023

Francesca Gale Head of Science Engagement

Before we start – the important bits



If the alarm sounds for more than one minute, please evacuate. Your host will guide you to the nearest assembly point



If you feel unwell or suffer an accident, let your host know and they will summon appropriate first aid



Please stay together and with your host(s) at all times during your visit



All buildings on the Campus are non-smoking

The core training team





Head of Science Engagement



Cindy Smidt

Science Engagement officer

Science Engagement Officer

Sam Shingles

Laboratory programme manager

Cassandra Soo

Laboratory Assistant

Aaron Dean



Jorge Batista da Roche Education Developer



Wellcome Genome Campus









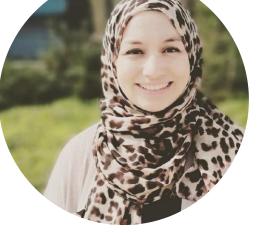
Areas of campus research





research fellows





research assistants



computer science apprentices



genetic counsellors



research students

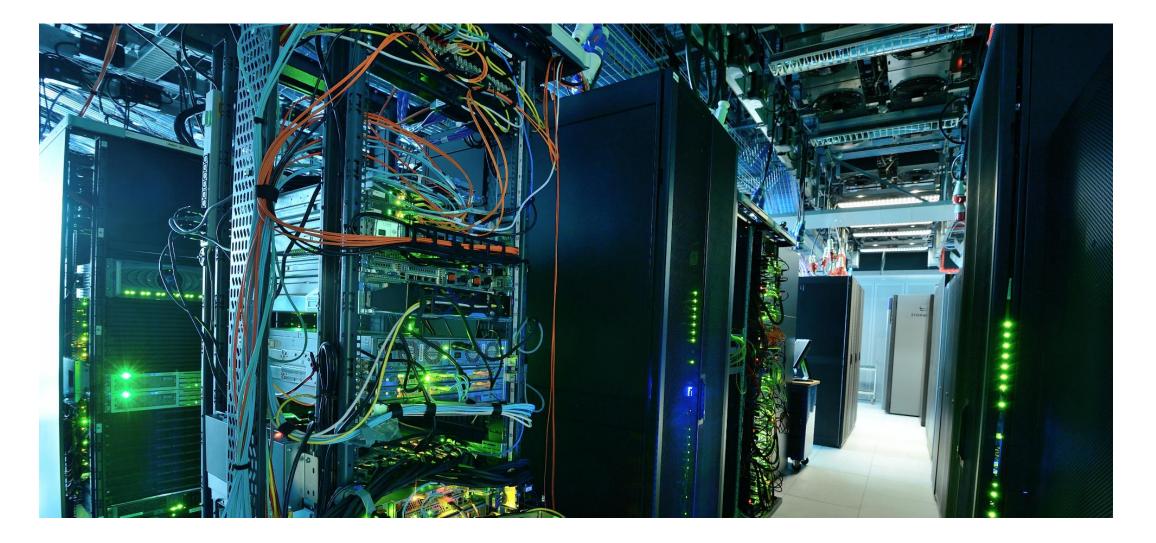
The Sequencing labs



Cellular operations



The data centre

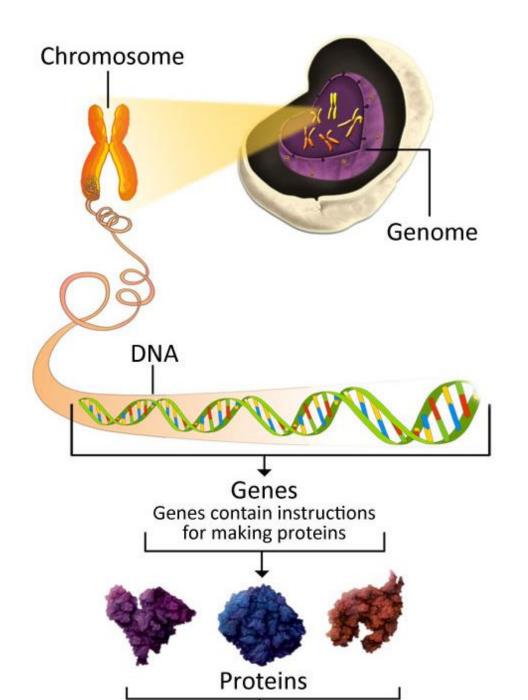


Time table for today

| Time | Activity |
|-------|---|
| 10:00 | Welcome and Introduction to the campus |
| 10:30 | Introduction to lab safety and our practicals |
| 10:45 | Lab practical – Pipetting skills and DNA extraction |
| 11:15 | Lab Practical – PCR |
| 11:45 | Speaker: Petra Korvelić |
| 12:15 | Lunch |
| 13:00 | Lab practical – running a Lonza Gel |
| 14:00 | Lab tour – CASM team |
| 15:00 | Reflections on the day |
| 15:30 | Depart |

What is a gene?

- A sequence of DNA that carries the information required to make a molecule, usually a protein.
- Proteins have functional roles to play in our bodies



What is a genome?

A copy of all the DNA instructions used to make an organism

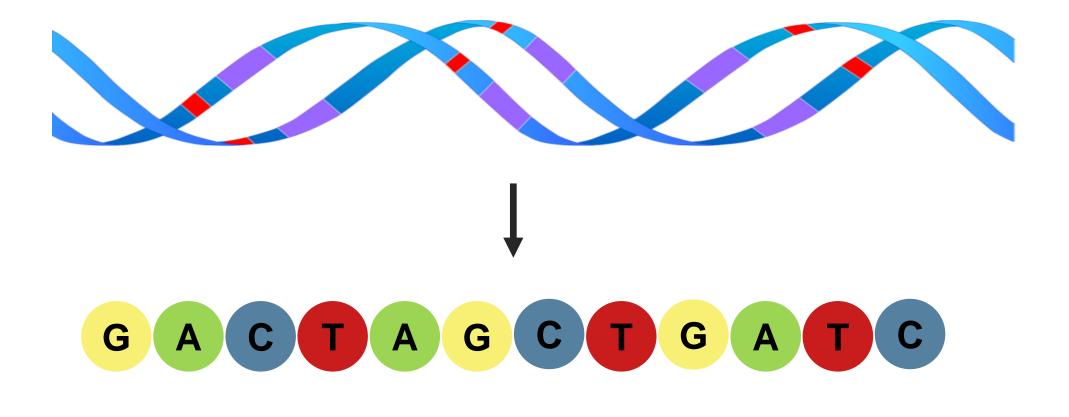
"The Book of Life"

All organisms have genomes

We have 2 copies of our genome packaged in 23 pairs of chromosomes



What is DNA sequencing?



genomics: then and now

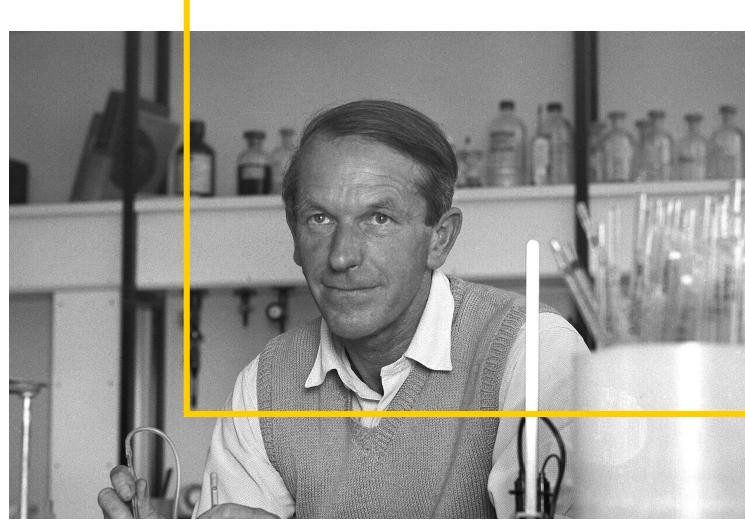


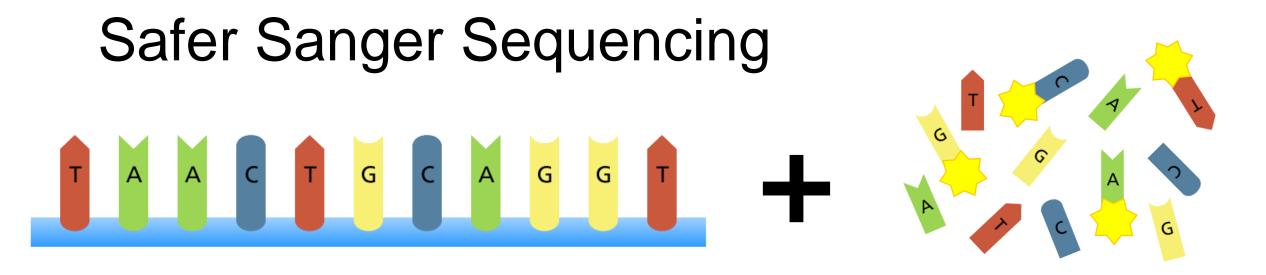
image credit: MRC LMB

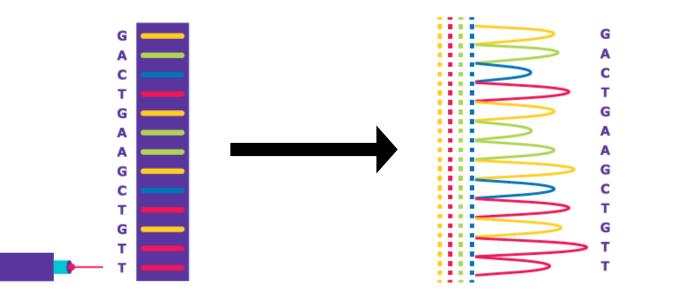
Fred Sanger and DNA sequencing

 First DNA sequencing methods was developed in 1977 by Fred Sanger and his team" at the Medical Research Council Laboratory of Molecular Biology in Cambridge, UK.

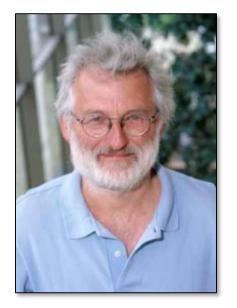
Based on the natural process of DNA replication, but used radioactively labelled "terminator" bases and gels to separate the DNA fragements



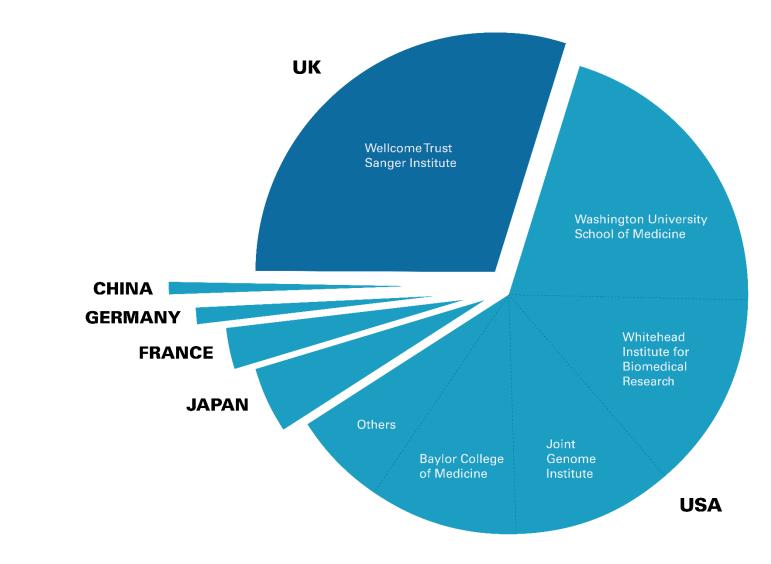




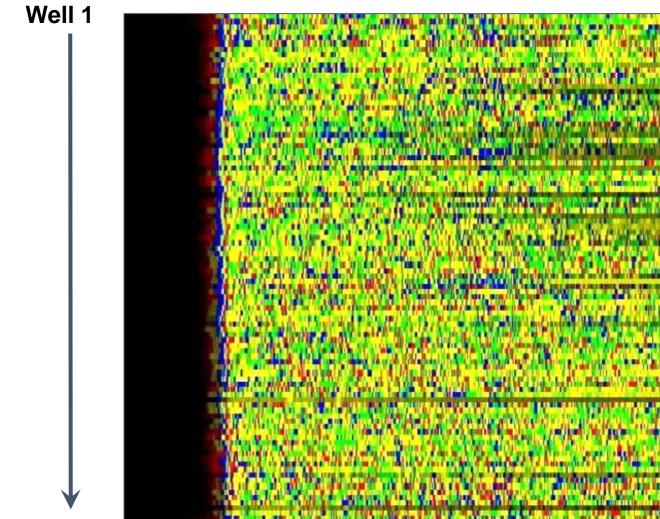
The Human Genome Project



John Sulston

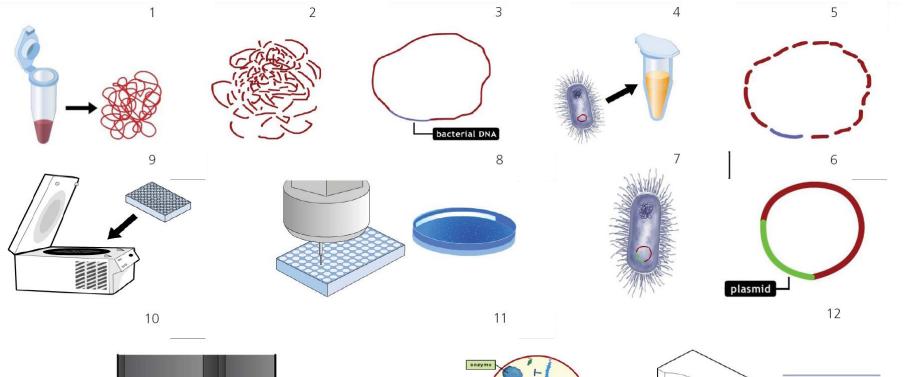


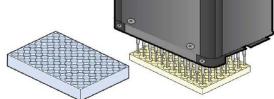
Sequence output (ABI 3700)

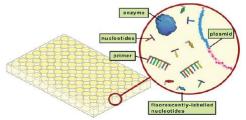


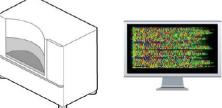


DNA to Data

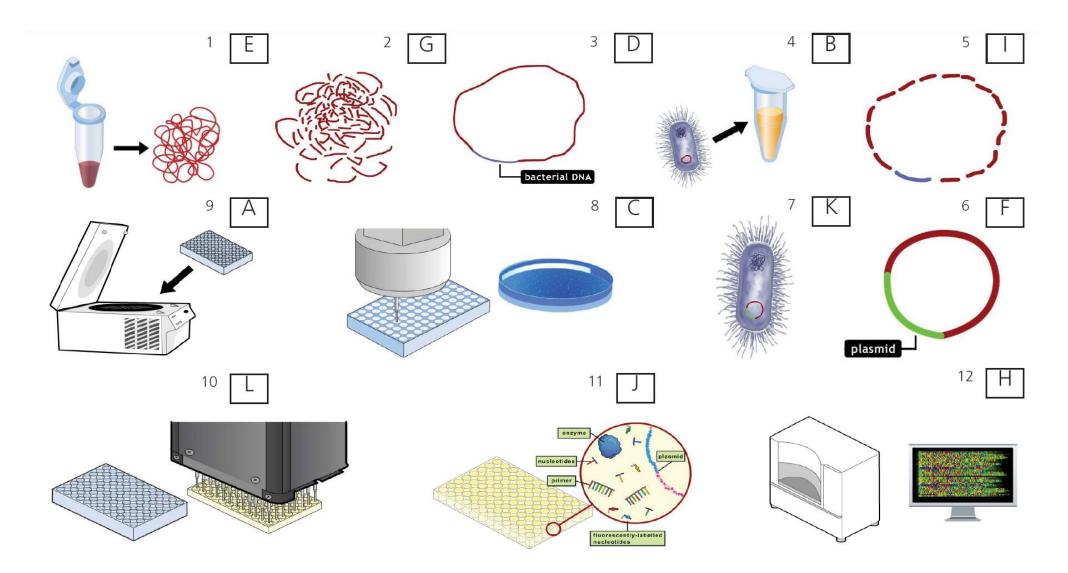








DNA to Data



What does a genome sequence look like?

Introns

Exons

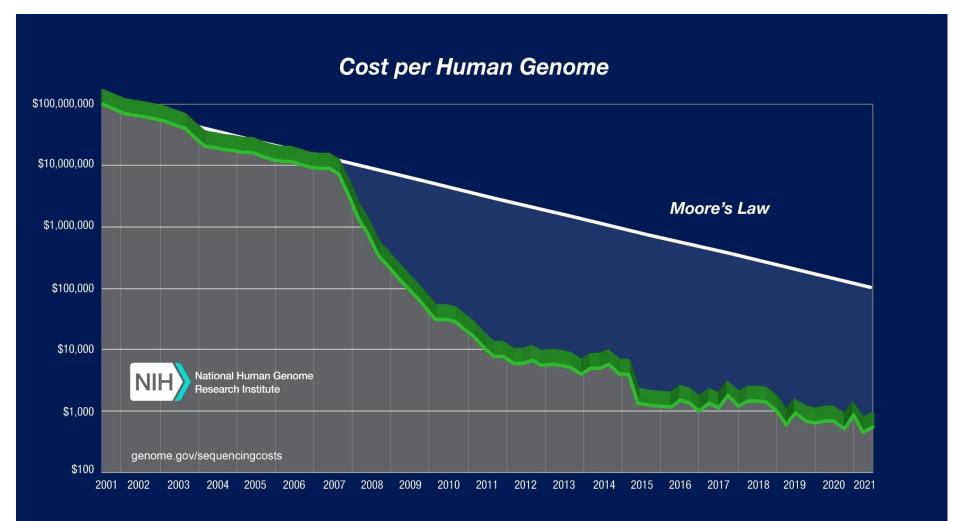
Non-coding DNA

| 19430551 | a cagt cag a cagg c cag a a t cagg c c t g g g c t g g g g g g g t c t c | |
|----------|--|------|
| 19430701 | t t c t g c c a c a a g g c a g a a c t a t g a c g a a a c t g a c t a g c c t c t c t g t a c a g a g t c a g a g c t a c g a g c c a c t c t g c c a c t g c c a c t g c c a c t g c c a c t g c c a c t g c c a c t g c c a c t g c c a c t c t c t c t c t c t c t c t c | In |
| 19430851 | tgtgccctatctgcccaaccctagttcaccctgatgtcccagctcagcattaatcgtggatccttcgcgggggccccgggggcccccaaccctcttttagggaccacaattccccaactggggggcactgtccccagatgggggca | |
| 19431001 | gtaacagtccctcttgcagatttcggatcttcatcctgccactgaaaggccacaagggggatttcatcccggtttcaccttcaggaccgtctgagcacttctcgggcgatgcagaccagtggaaggcactggctgg | |
| 19431151 | cctgggagccaggccgcgcccctccaaggaccacaggtgggcagcggaagactcagagcaagagccaggggcgaagatggccctcgctgcggtcaacccggagcacgtgctgggggctcaccagcctctccgcggggcgaagatggccctcgctgcggtcaacccggagcacgtgctggggctcaccagcctctccgcggcgaagatggccaaggtcg | |
| 19431301 | ctcccgccggcttcttgggctccgggtaccgggcgtcagggggggg | |
| 19431451 | acccaggtcggcttcaggagcttcattgttcggccgccgccgccggcgggctgaggcgagcgccgggtccctcagcgcgcccggggccatggagccaccgccgcttcctcccgcgccccccgccccccgccccccgcccccc | |
| 19431601 | cete agggeegeegeegeegeegeegeegeegeegeegeegeeg | |
| 19431751 | gcacctgccaaatcgccccggcgggaaaccgctccccacgcggactgggccgccccggctcctccgctgggggggtcgggccccgggcgcggggcgcccagaaagggcggttcgcctggacggcggacagcggggcggtcgggcccgggcgcccagaaagggcggttcgcctggacggcggacagcggggcctg | |
| 19431901 | $c_{agttgcaacccgggccgcccgccagaggcagggggcccaggtggcccgcgccgtcaccagctctgcccagtctgagtccgacttattaactagcttccgtcattcat$ | |
| 19432051 | ggeteegeeggeeggegeeggaatgegateegggetteggaetegaaegaa | |
| 19432201 | | E |
| 19432351 | a coord a good of the set of t | |
| 19432501 | gcaccgcgggccggactgtggggggggggcgcacggcgggggggg | |
| 19432651 | tgcggggtcttcgcgactgtccgccaggactcgcctgtgctccctgctcgcctcccagtccacgaatatctcagggatgagccatctggtcgtgactcttatgcatgaaaaatctgagcaccctggcgagcagcggtcctgcttaagtcct | |
| 19432801 | ctgtggtctgaacgaaagattttgaaaaaccttccacgttgaccttgctgtcatatcaagtagttagaagtgccccgggtttgggagcattgcaattttttattttcctgtgaagtgggggagagaatcagatatttatt | |
| 19432951 | a cagagtetegetetgtegeceaggetggagtgcagtggegegattteggeteactgcaecetetgeeteegggtteaageagttetgeeeeggeteeeggagtageteggattacaggegeeeaacaeceggetaatttttgt | |
| 19433101 | atttttagtagagacggggtttcaccatgttggccaggctggtcttgaactcctgacctcgcgatccacccgcctcggcctcccaaagtgctggggattacagacgtgagcaaccgcgcctagcctggagaagcagatatttatacatac | |
| 19433251 | cttgtatctttcaggcttctgggaacttggcagacgcagcttagagagactcaccagcgagcg | |
| 19433401 | gtagagaacaaagcaagaatgctggatgtgggtttgcaaaattaacagcctacaaagtttctcagttaaatttaggccgatgcttttctgtttttccaacattttccaaaccatagattgttgttgttagtaatttttaaaatttgagcagt | |
| 19433551 | t t c t c a gaag ta agta agta t t c t c c t t g a agg g a t c t t g t g t t t t a a agg a c a c ag c t t a a g t t c t g t t c t c c t t c c c t g c c c a t c g g a g g c c t g g g g a g a t g c a g t a t t a a agg t a t t c c c t g c c c t t c c t t c c c t g c c c a t c g g g g g a g a g d g t g g g g a g a t g c a g t a t t a a agg t a t t c c c t g c c c t c c t c c c t g c c c a t c c g g a g g g c c c t g g g g g a g a g d g g d g d g d g d g | |
| 19433701 | catctggcactctcgactcttgtagatacttgatcagtcaatcttgatagtaaaggatttgattttctttttttt | |
| 19433851 | ctcctgggttaaactaattctcctgcctcagcctcccaagtagctgggattacaggcgcccactaccacgcccggctaatttttgtgtttttagtagagacgggggtttcaccatgttggtaggtggtcaggctggtctcgaactcctgat | |
| 19434001 | ctcaggtgatccacccacctcagcaccccaaagtgctgggattacaggcctgagccaccgcacccagtccacaatttaatagtaataagcttctaatctaacagtttggtattttcacttttgagtgtaatcccaaggcacacct | |
| 19434151 | gaatcccagcaataaagaggaacacttcccgattttataccctgatgcctcttgttgcttttgtactttttttt | |
| 19434301 | caacctccgcctcccaggctcaagtgattctcctgcctccaggctgcgaagctggggattacaggtgcgcaccaccaccacgctaatttttgtatttttagtagagacagggtttcgccatgttgaccaggctggtctcgaactcct | |
| 19434451 | gaccttgggcaatctgcccgcctttgcctcccaaagtgctggggattacaggcctgagccactgcacccggctgcttttgtactattcttgtaattgatggcacctacacagttctcacaagtactgtggggtggggtggggtgcactcctcaccacagttctcacaagtactgtggggtggggtggagtacctcctcaccacagtactcgtggggtggggtggggtggggtggggtggggtgcactcctcaccacagtactcgtggggtggggtggggtggggtgcactcctcaccacagtactcgtggggtggggtggggtggagtacctcctcaccacagtactcgtggggtggggtggggtggggtggggtggggtggggtgggg | |
| 19434601 | cgctgagctcatgagttagtcatgcacagctccttcccccagtgggggggg | |
| 19434751 | aaaaaagaaggtagatcotaaaaaagaccaaggagcgcttgaaaaggaagatcogaaaactggaaaaggctactcaagagctaattootattgaagattttattaccootctaaagttottggataaaggataagg | |
| 19434901 | a tccttctctagggatgaagtcctcaggacaaaggagtaatatcaacttcaggtagttgtgtctgtagttcacacctgtgatagtcattggtcagtaggcttgagctgacttggccctaatgagtccttgctccttttggaagcaggaga | |
| 19435051 | a a g catcett g g t g t a ctett g a a t g g c t c t g g g t g g g a a a g a a c c t a a g a c a t c t a a t a a t c a g a t g c t c t g g g t g t g t g t g t g t | |
| 19435201 | gtotgaagcoctcgcctcatcctaacagtagaaaacccttggcctcctgttttatcatgcagatatctttggtggtatttgtgggattctactgtgtgcagggttaacagctcctgctgccgcttttgtaagcagtgtgcaccatctat | |
| 19435351 | a a agggg c aggtg t t a a a agt c t t c t c t c c c c a aggg ag t a t t t g c t g g g c a g a g g a g t g c t a c c a g t c c c c c a g t c c c c c a g t c c t c t t t t t g a c a g a g c c a c a t c a g t t g c a g c c a c a t c a g t c a g c c a c a t c a g t c a g c c a c a t c a g t c a g c c a c a t c a g t c a g c c a c a t c a g t c a g c c a c a t c a g t c a g c c a c a t c a g t c a g c c a c a t c a g t c a g c c a c a t c a g t c a g c c a c a t c a g t c a g c c a c a t c a g t c a g c c a c a t c a g t c a g c c a c a t c a g t c a c a t c a g t c a c a t c a g t c a c a t c a g t c a c a t c a c a t c a c a t c a c a | |
| 19435501 | a cattee attet tattigtee caa acttigt ttatetee tagteetigt of the second | |
| 19435651 | gtggageteacetttgaggagaetgagaggagagetetgettetgaagaagtggteettgtaeaageageaggagggag | |
| 19435801 | t ccccga a get ccatget g a ggec a tea a geg gg a test a a cet gt te ccctt t g a g a a gg g c a catt a c a ce c a cet a cet a ce c a a gg c a gg t a cat g a cat cat ca ce ca g g t g a cat cat cat cat cat cat cat cat cat c | |
| 19435951 | | |
| 19436101 | ttttttaaaaaatttttttttgagacagagtctcactctgttgcccaggctggagtgcagtgacgcaatctcggctcactgcaaactctgtctctctgggtcaagcgattctcctgtgtcagcctcctgagtatctgggattaccagggtgtcagtgtgtcagtgtcagtgtcagtgtgtcagtgtgtcagtgtgtcagtgtgtgt | N I |
| 19436251 | gcaccaccaccgcgtggctaatttttgtatttttaggagacagagttttgccatgttggccaggctggtctcgaactcctgacctccagtgatccgcctaccttggcctcccaaagcactgggattataggcatcagccaccgcccagc | - IN |
| 19436401 | cagaattaaaattaattcaccaggccaggctcagtggctcatgcctgtaatcccagcactttgggaggccaaggcaggtggatcacgaaatgaggtcaggagatcgagaccatcctagctaacagtgaaaccccatcttactaaaaata | |
| 19436551 | caaaaaaaattagctgggcatggtggcggcgcctgtagtcccagctactcaagaggctgaggcaggagaatggtgtgaacctggggggtggaggttggagcttgcagtggggcgagatcacaccaccgcactccgggctgggggggg | |
| 19436701 | | |
| 19436851 | | |
| 19437001 | | |
| | | |

DNA sequencers then vs now

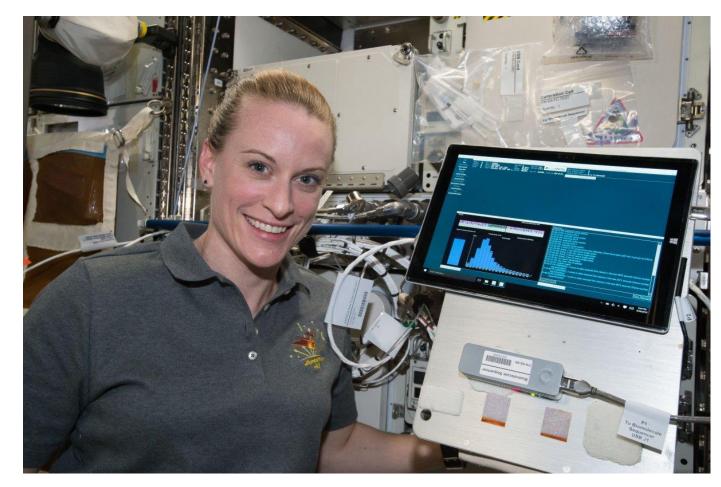


DNA sequencing today

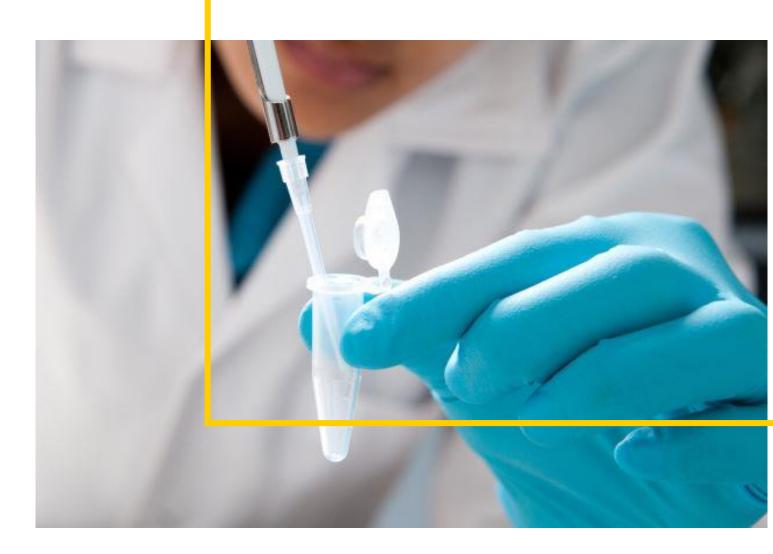


Sequencing everything and everywhere





Getting ready for the lab session



Virtual lab log in

genomeresearch.itslearning.com

User name: your email Password: password

Change your password once you have logged in

Working Safely in the Lab

Complete Module 2 Working safely in the lab simulations:

- Dressing for the lab
- Lab safety simulation





What are the key lab safety rules?







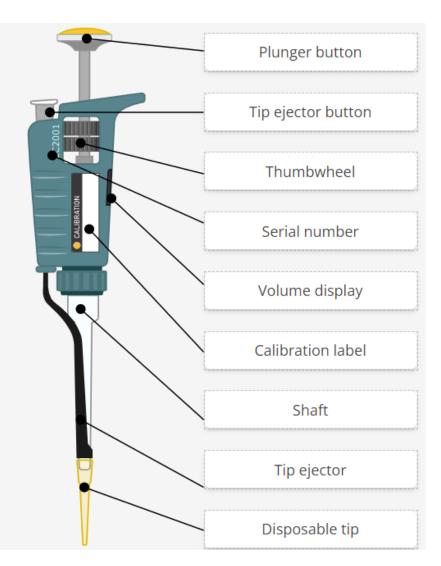
Practical skills: Pipetting



What is a pipette?

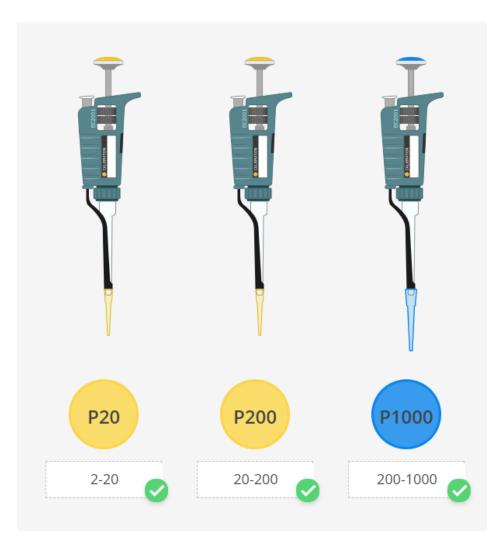


Key parts of a pipette





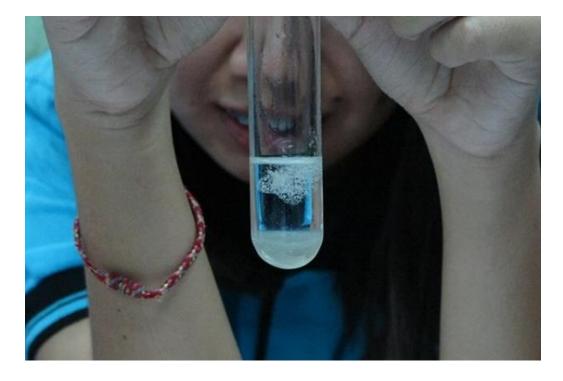
Sizes of pipette



Practical 1: DNA extraction

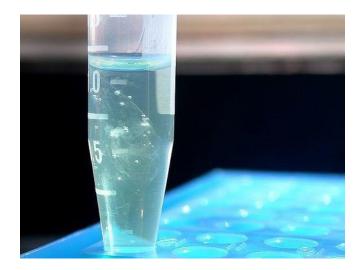
Aim:

 Understand three main stages involved in extracting DNA from plant cells and animal cells.



Stages of DNA extraction

- The process of DNA extraction is fairly straightforward, incorporating the following basic steps:
 - 1. Breaking cells open
 - 2. Separating DNA from proteins and other cellular debris
 - 3. Precipitating the DNA with an alcohol
 - 4. Cleaning the DNA (purification)
 - 5. Confirming the presence and quality of the DNA



Practical 2: PCR

Aim:

• Understand the processes involved in carrying out a PCR reaction.



Practical 2: PCR

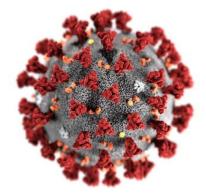
Polymerase Chain Reaction

Uses cell's mechanism of DNA replication to make lots of copies of small sections of DNA

Why would that be useful?

Uses of PCR

- Detection of Virus or bacteria
- Identification of Individuals (DNA fingerprinting)
- Identification of species (DNA barcoding)
- Diagnosis of genetic disorders



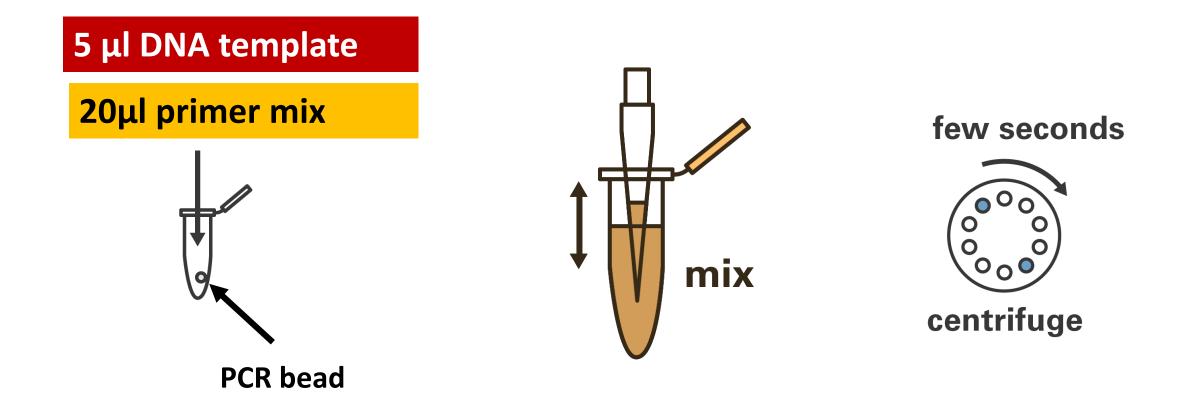




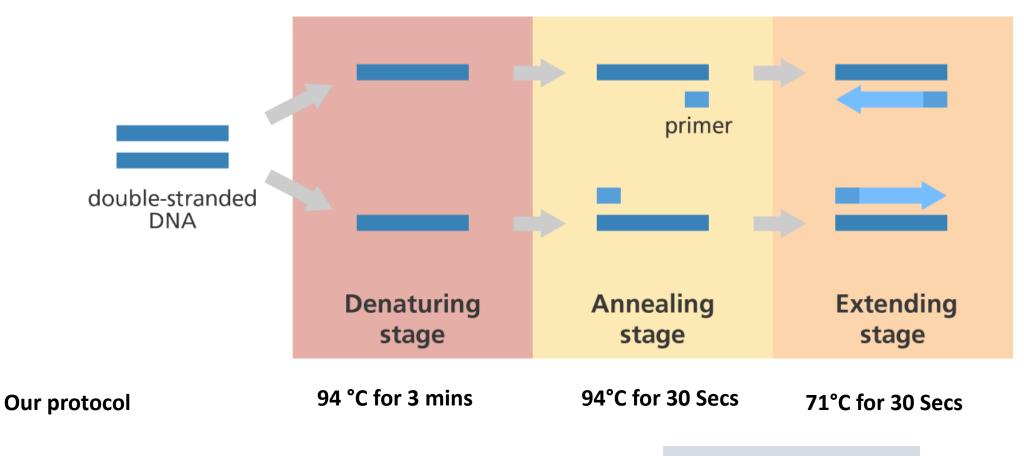
What do you need for a PCR reaction?

- A DNA template to be copied
- A primer a short piece of DNA that is designed to bind with the DNA you want to copy
- DNA bases the building blocks of the DNA molecule
- **DNA polymerase** enzyme to build the new DNA fragments
- Buffer this ensures the conditions remain stable for the reaction to take place.
- A thermal cycler a machine that heats and cools the sample

What will we be doing in the lab?

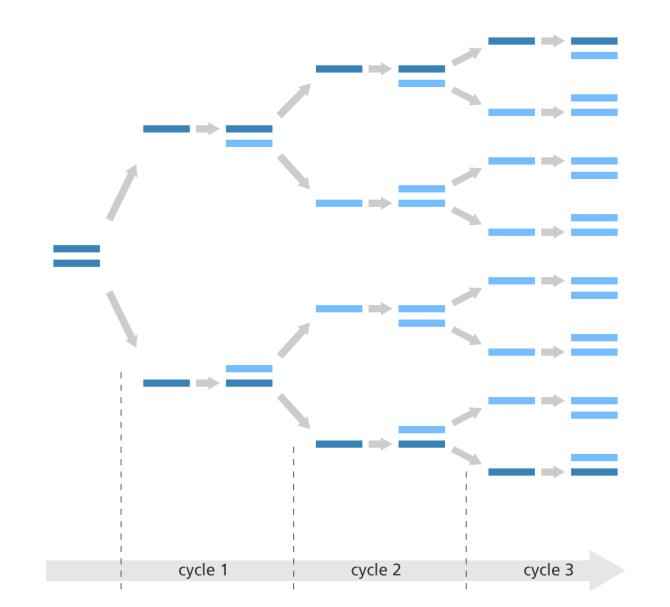


PCR cycling conditions



Repeat for 20 cycles

What will be happening in the PCR machine

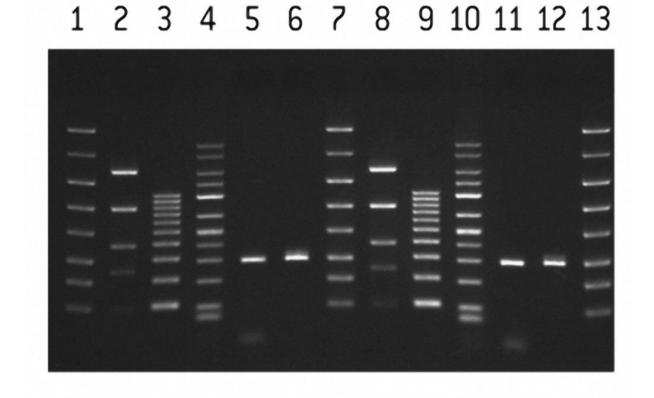


Using the Lonza Flashgel system



Visualising results

Gel electrophoresis can be used to view whether your PCR has been successful



Lonza Flashgel (Gel electrophoresis)

