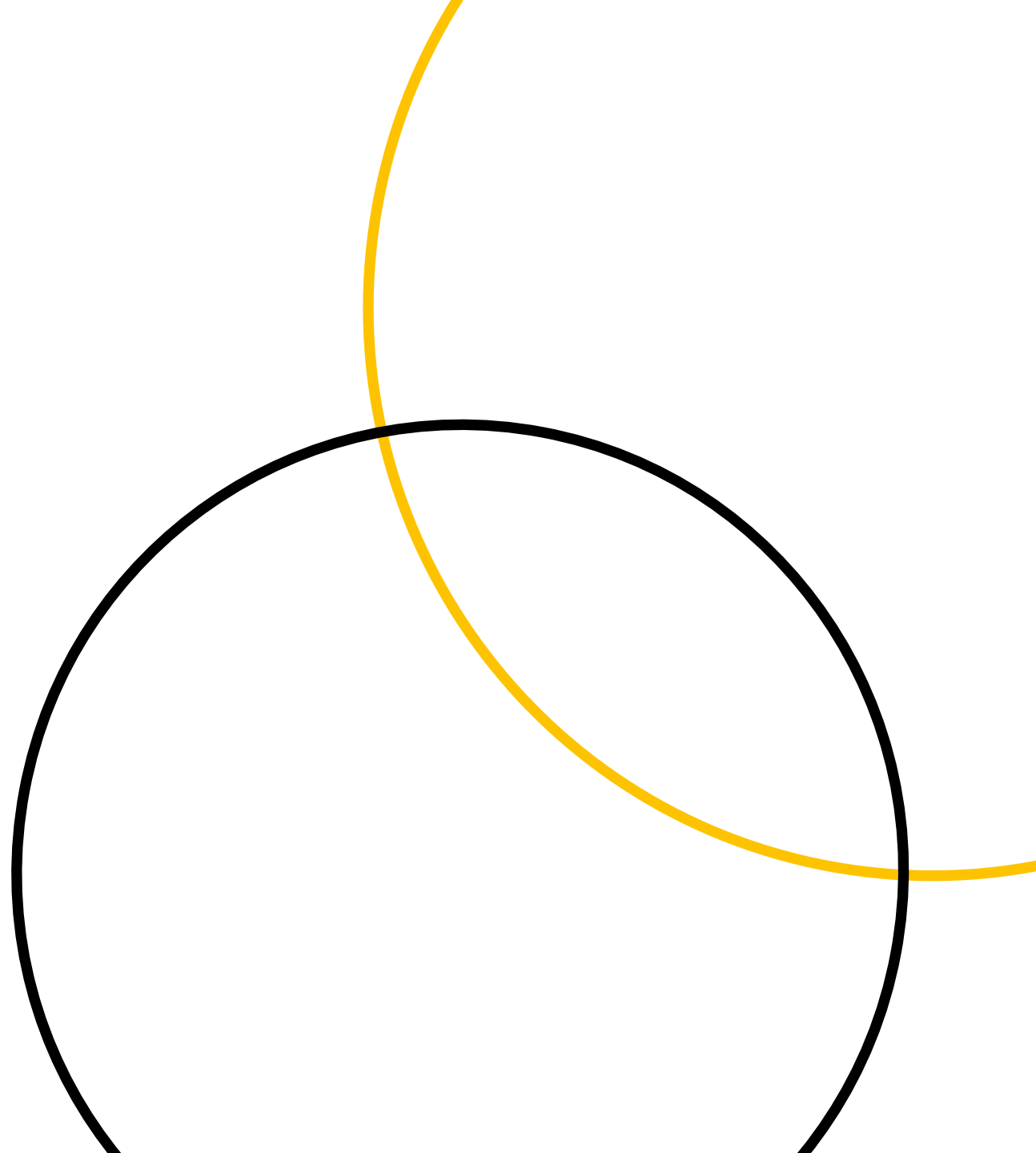# Genome Academy: DNA to Data

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

Fran Gale

Head of Science Engagement

Cindy Smidt

Science Engagement officer

Sam Shingles

Science Engagement Officer

Cassandra Soo

Laboratory programme manager
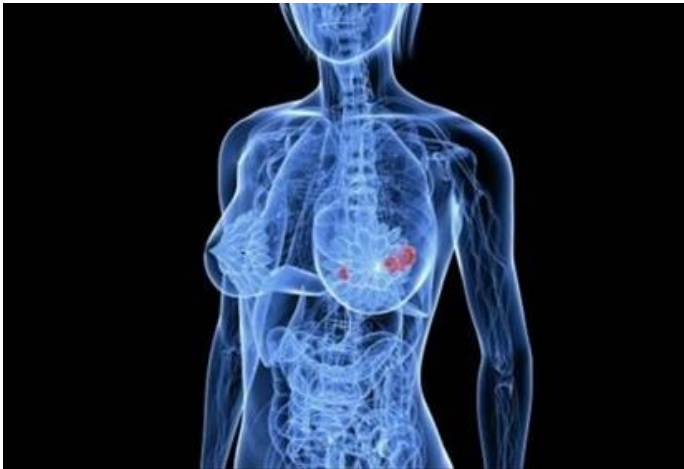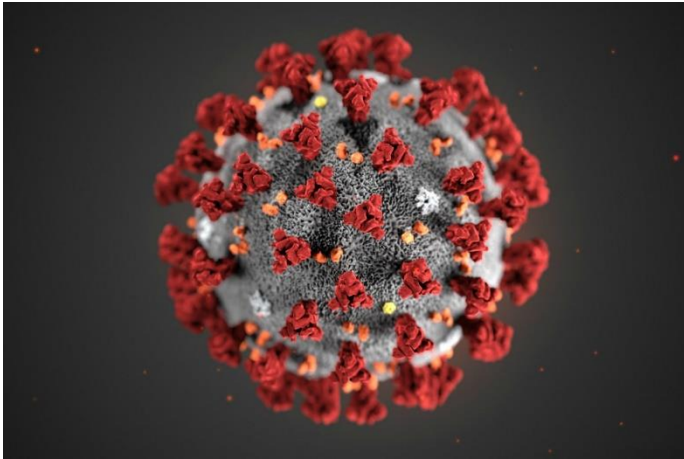
Aaron Dean

Laboratory Assistant

Jorge Batista da Roche

Education Developer

wellcome connecting science

Wellcome Genome Campus
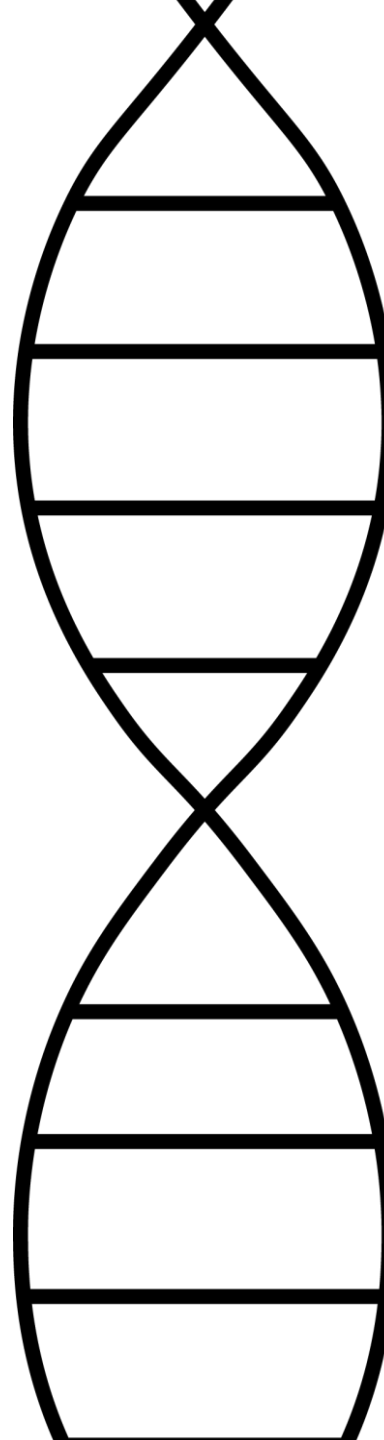
Areas of campus research

group lead

computer science apprentices

research fellows

research assistants

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.
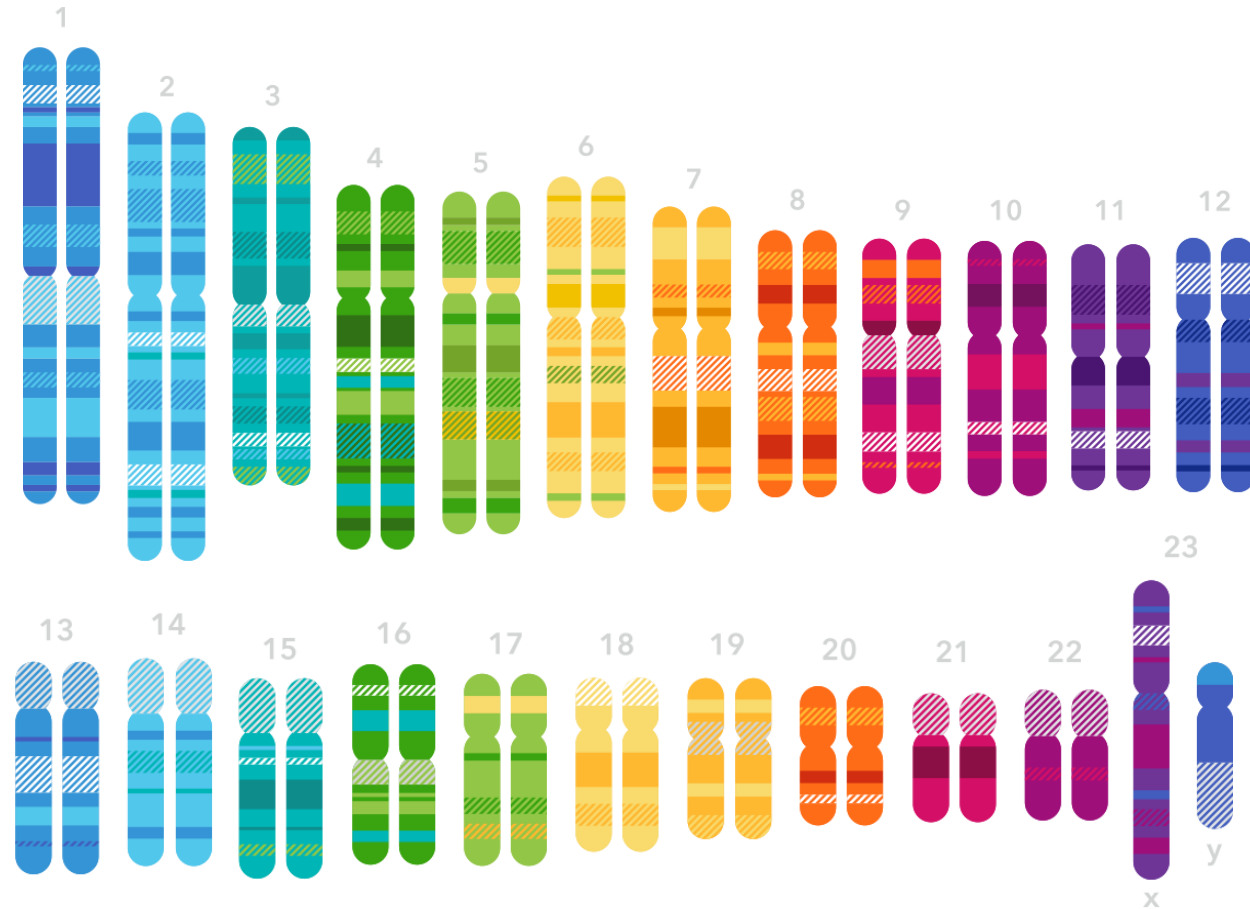
- Proteins have functional roles to play in our bodies

Chromosome

Genome

DNA

Genes
Genes contain instructions for making proteins

Proteins

What is a genome?

A copy of all the DNA instructions used to make an organism
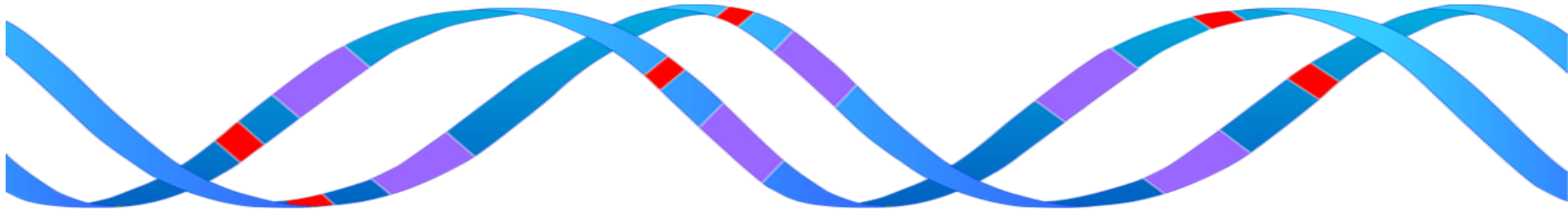
"The Book of Life"

All organisms have genomes

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

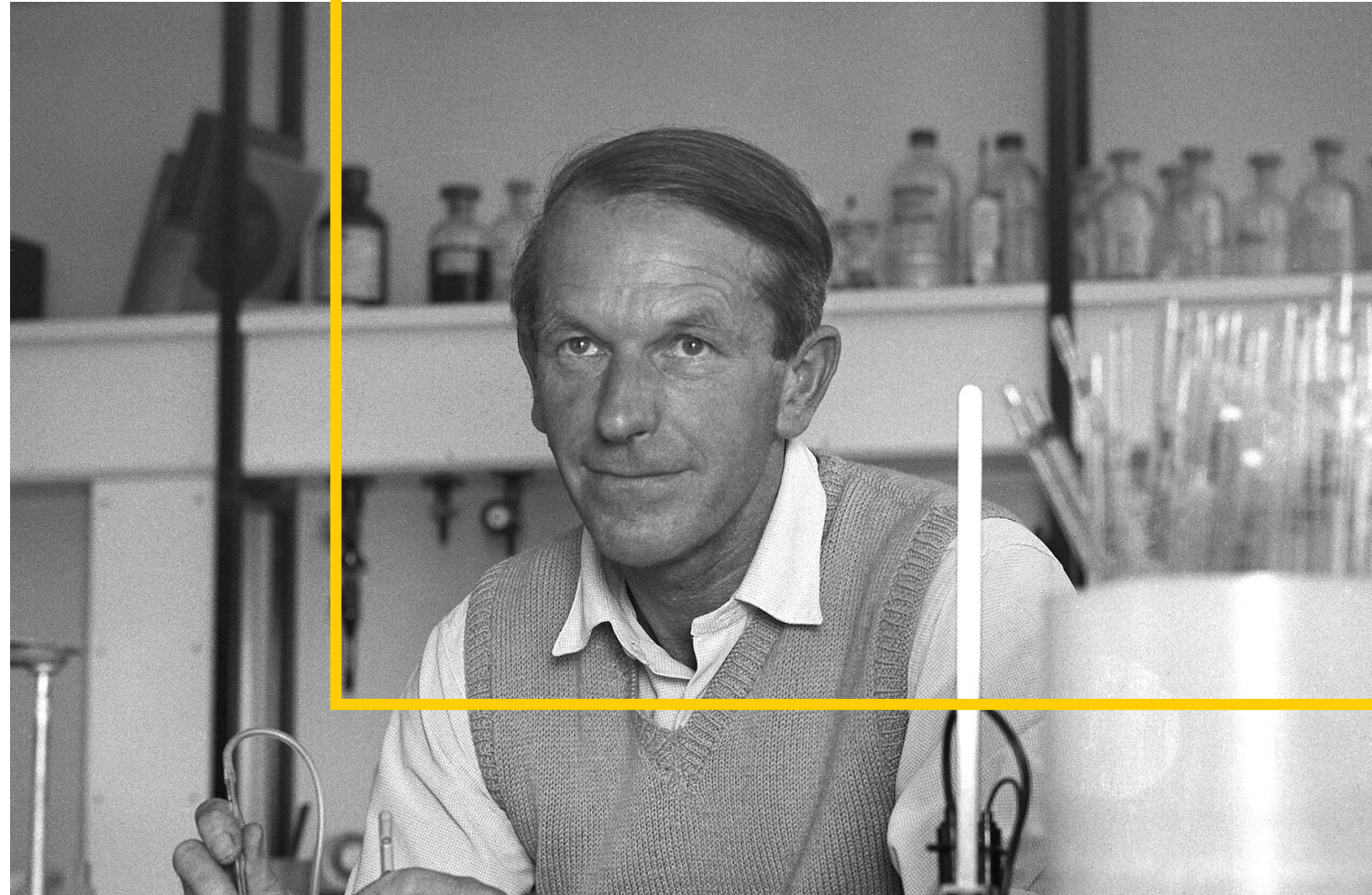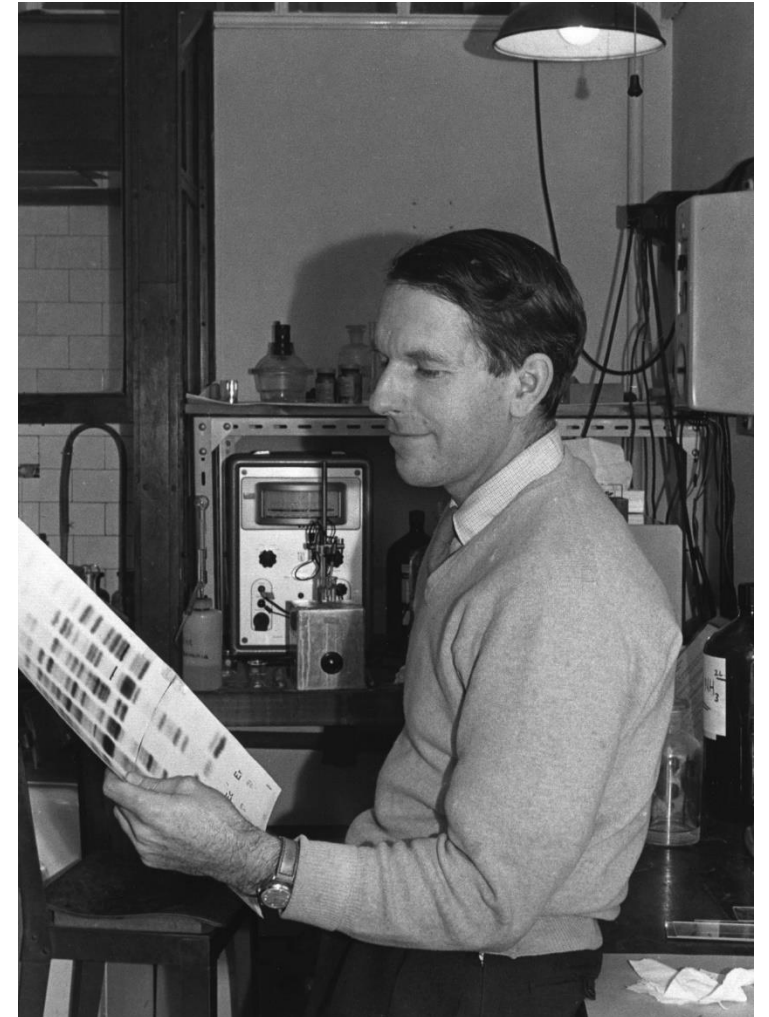# What is DNA sequencing?

genomics:
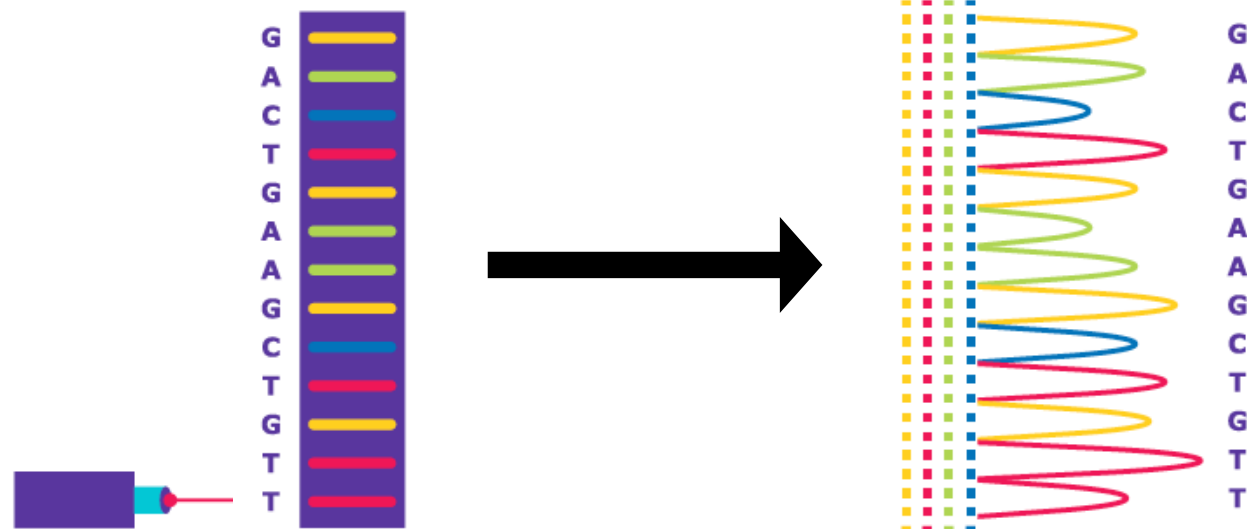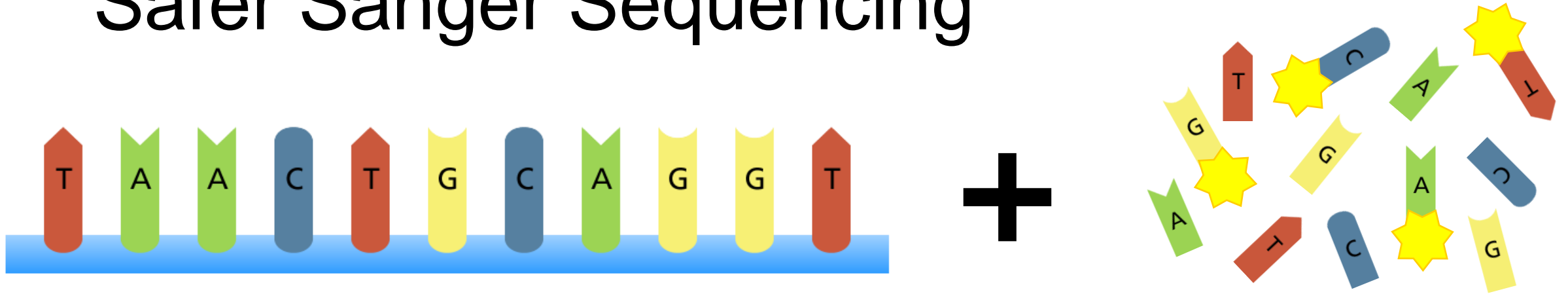# then and now

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
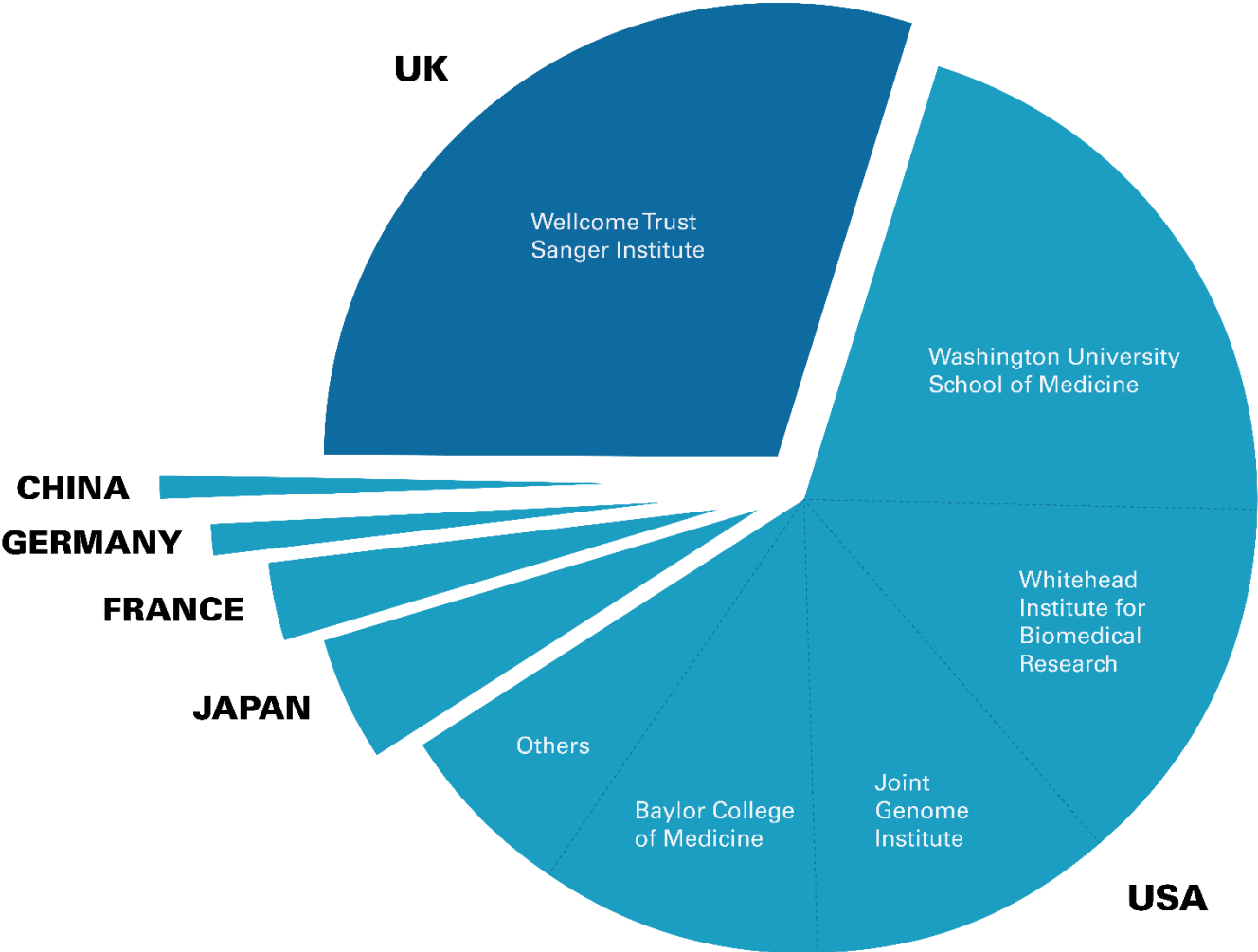
Safer Sanger Sequencing
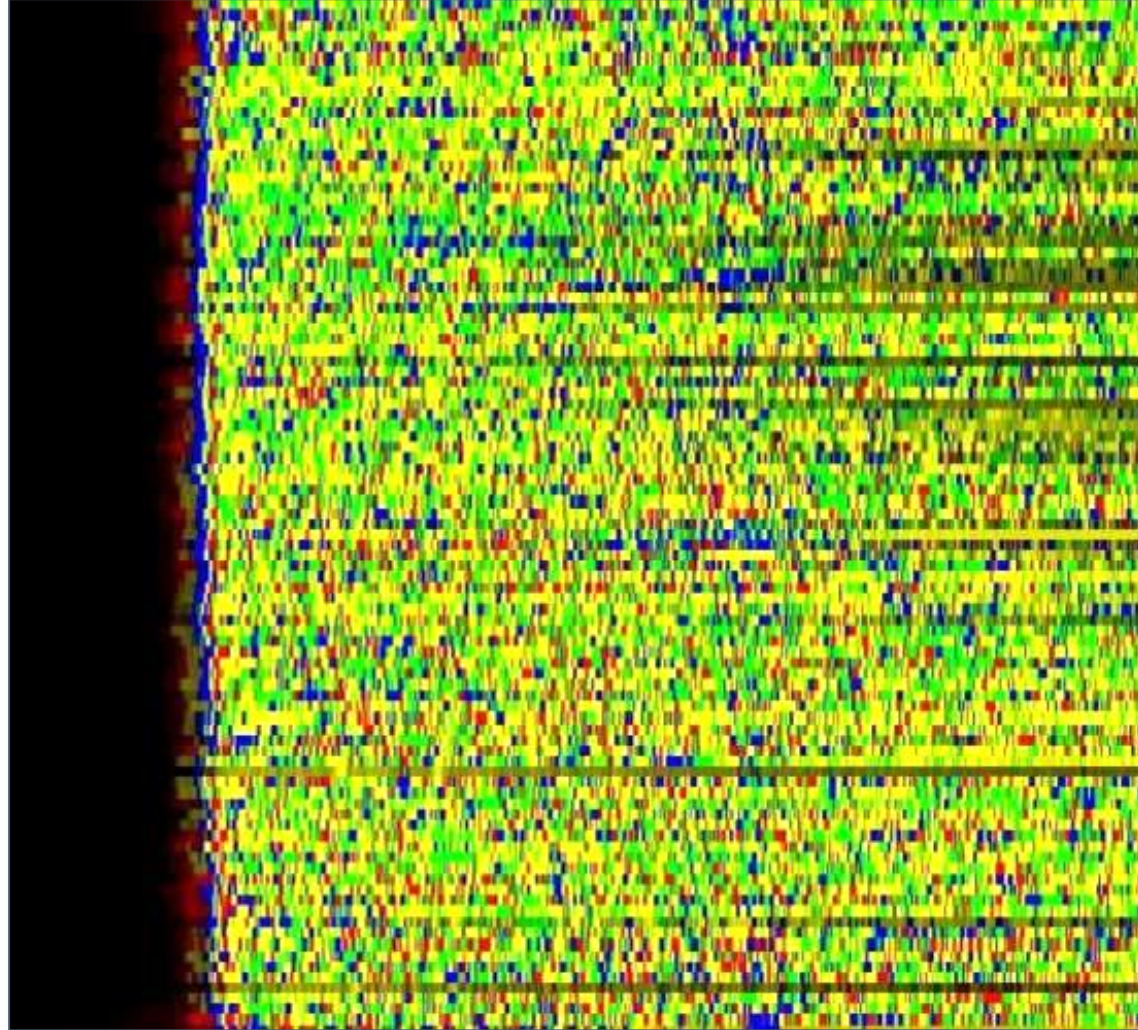
The Human Genome Project

John Sulston

UK
- Wellcome Trust Sanger Institute

CHINA
GERMANY
FRANCE
JAPAN

Others

USA
- Washington University School of Medicine
- Whitehead Institute for Biomedical Research
- Baylor College of Medicine
- Joint Genome Institute

Sequence output (ABI 3700)

Well 1

Well 96

DNA to Data

DNA to Data

What does a genome sequence look like?

Introns

Exons

Non-coding DNA

DNA sequencers then vs now

DNA sequencing today

Cost per Human Genome

Moore's Law

National Human Genome Research Institute

genome.gov/sequencingcosts

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
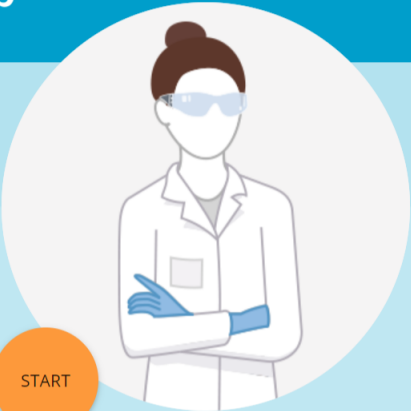- Lab safety simulation

Safety

Dressing For The Lab

By the end of this interactive, you will be able to outline the basic dress code that allows you to work safely in a lab.

Always check local rules before working in the lab

- Dress appropriately for the lab
- Outline the function of basic personal protective equipment (PPE)

START

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Safety

Safety Features and Hazards

By the end of this interactive, you will be able to outline the basic safety rules that should be adhered to when working in a lab.

Always check local rules before working in the lab

- Identify common lab safety equipment such as fire extinguishers and eye wash stations
- Identify hazardous behaviour in a lab
- Outline the steps you should take before leaving the lab

START

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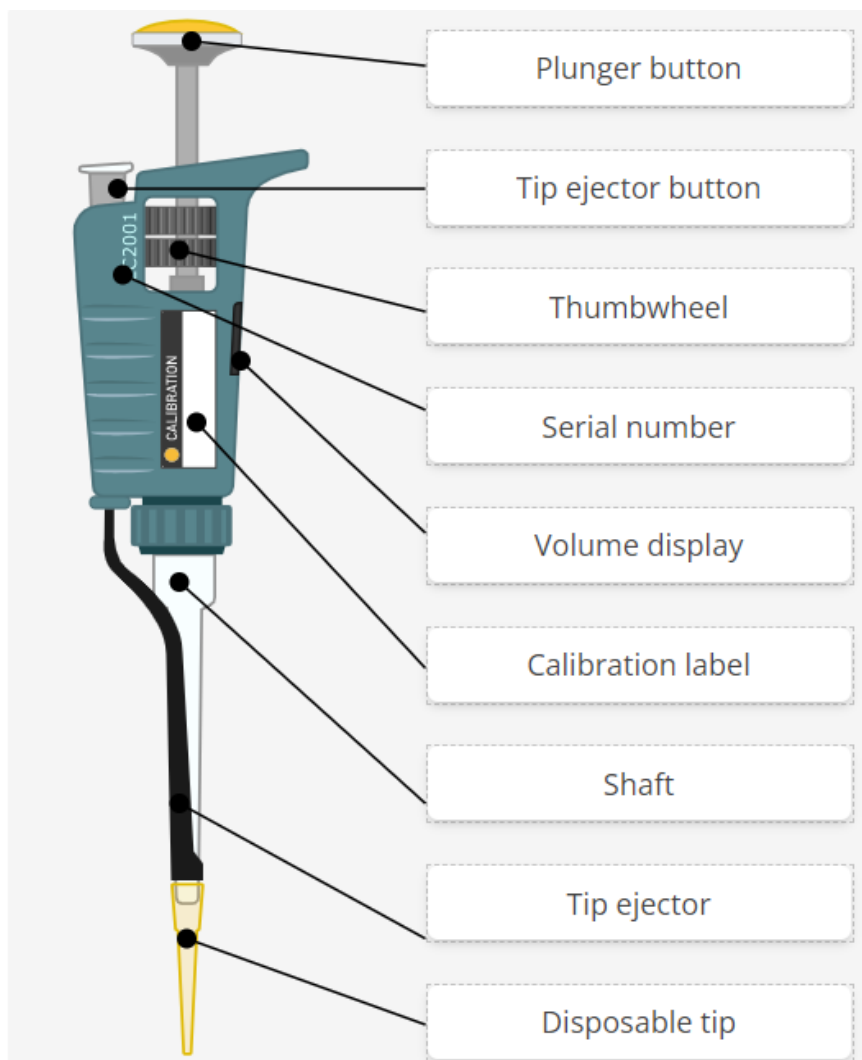
What are the key lab safety rules?

Practical skills: Pipetting

What is a pipette?

Key parts of a pipette

Plunger button

Tip ejector button

Thumbwheel

Serial number

Volume display

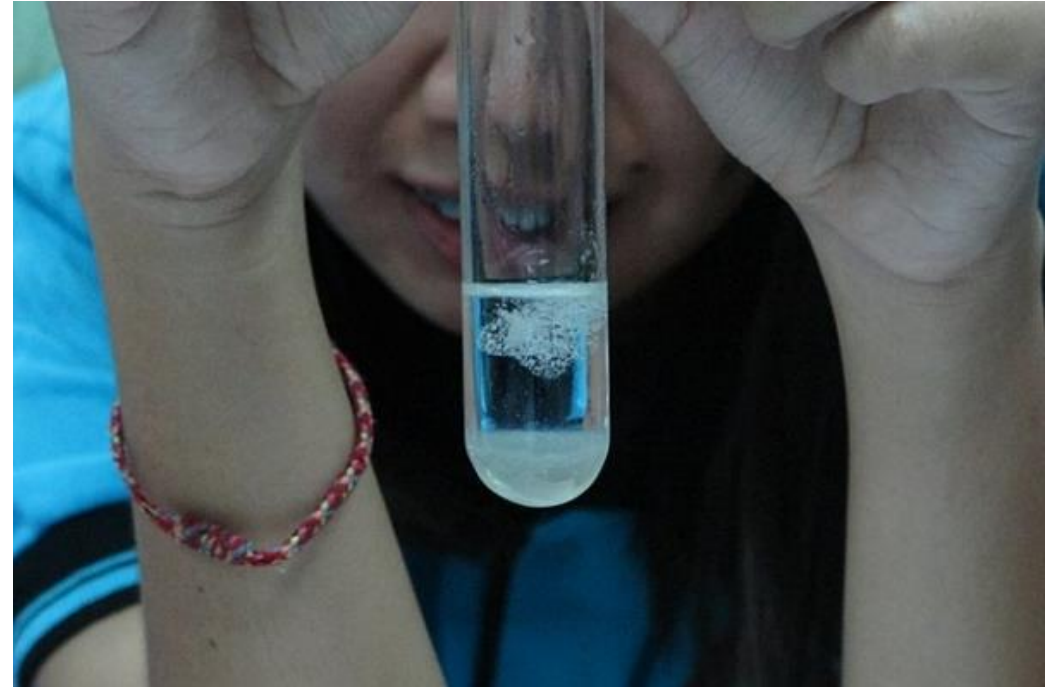Calibration label

Shaft

Tip ejector

Disposable tip

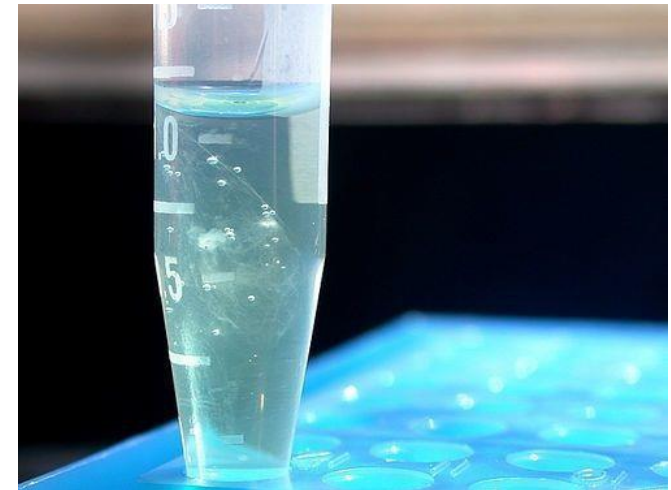# Sizes of pipette

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:

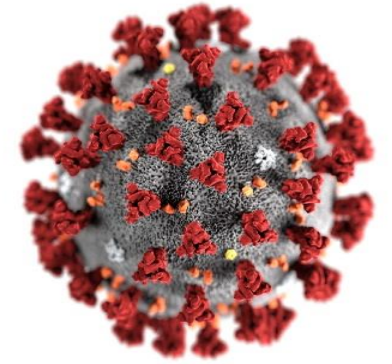- Understand the processes involved in carrying out a PCR reaction.

Practical 2: PCR

Polymerase **C**hain **R**eaction

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)
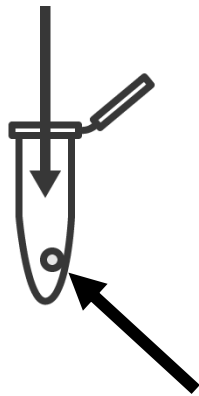
- Diagnosis of genetic disorders

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
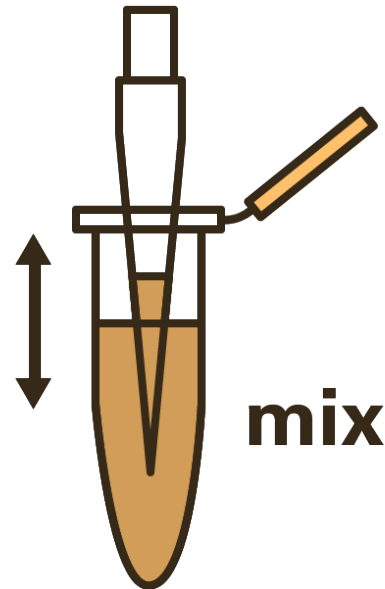
What will we be doing in the lab?
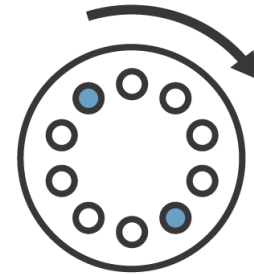
5 µl DNA template
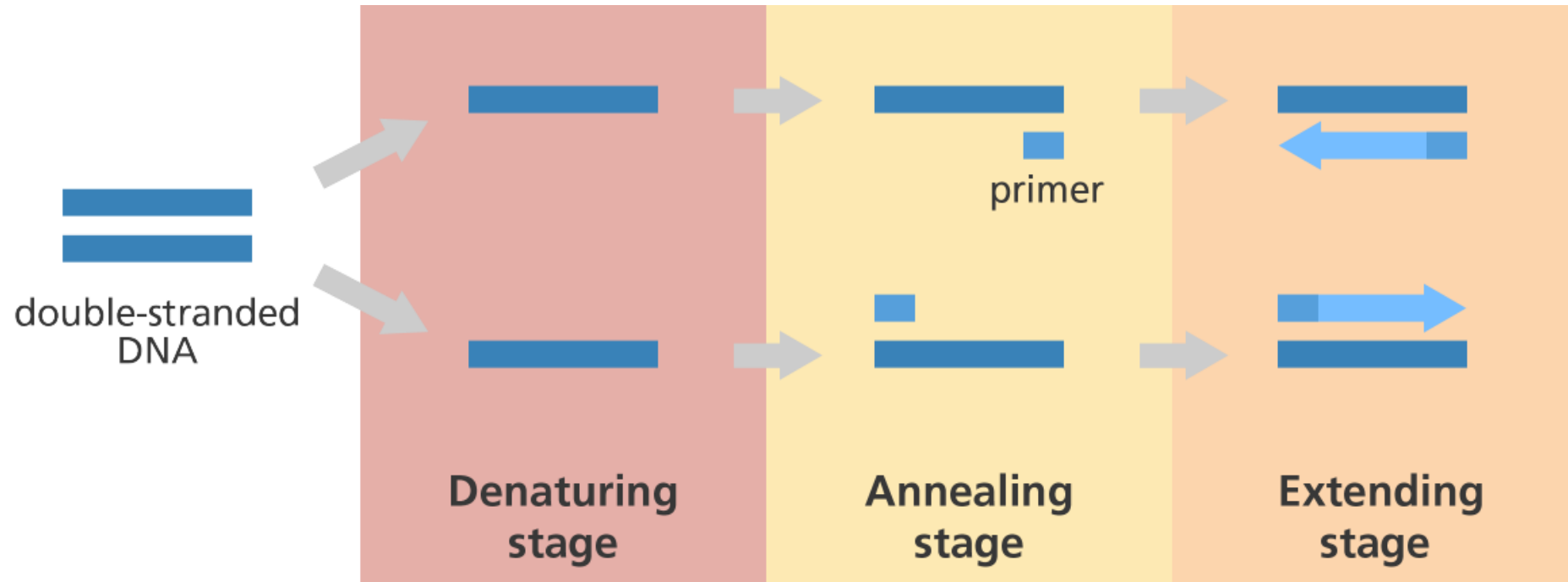
20µl primer mix

PCR bead

mix
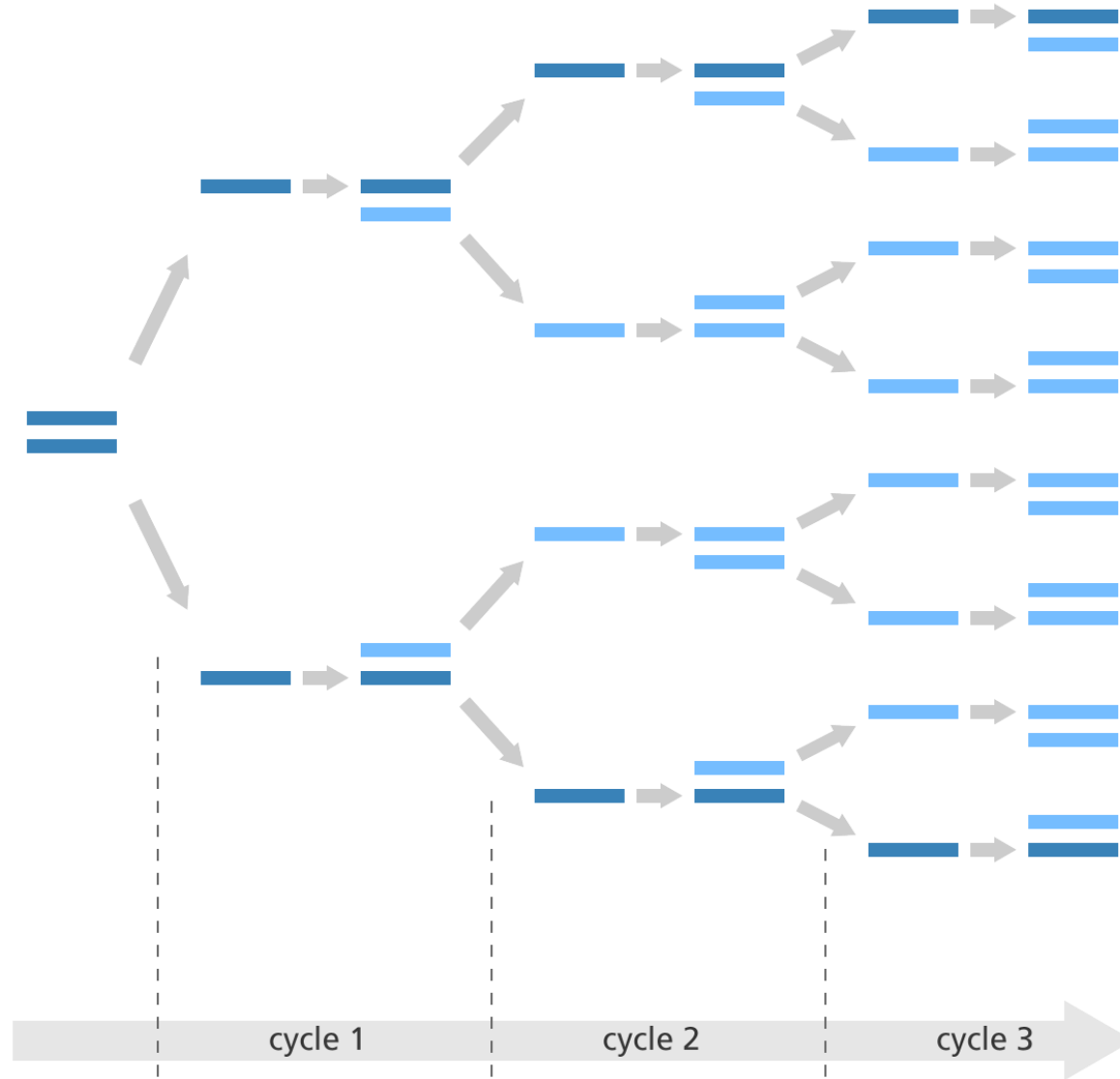
few seconds

centrifuge

PCR cycling conditions

double-stranded DNA

primer

Denaturing stage

Annealing stage

Extending stage

Our protocol

94 °C for 3 mins

94°C for 30 Secs

71°C for 30 Secs

Repeat for 20 cycles

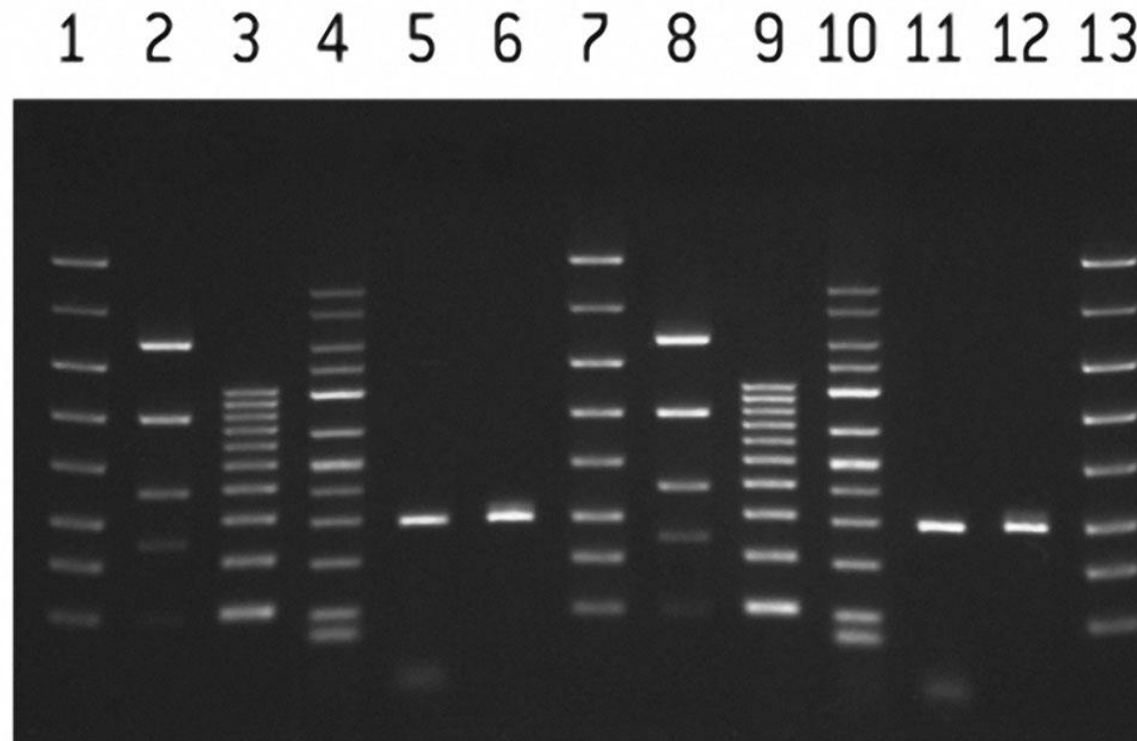# What will be happening in the PCR machine

cycle 1 cycle 2 cycle 3

Using the Lonza Flashgel system

Visualising results

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

Lonza Flashgel (Gel electrophoresis)