

Unravelling the code of life

1869: Nuclein – now known as **DNA** or deoxyribonucleic acid – isolated from nuclei of white blood cells

1879: Chromosomes discovered within nucleus of cell

1900: Building blocks of DNA established as phosphate and sugar (deoxyribose) and four bases (nucleotides) **adenine (A), cytosine (C), guanine (G), thymine (T)**

1933: Chromosomes shown to contain DNA

1941: “One gene-one protein” hypothesis

1944: Discovery that DNA, not protein, is material of inheritance

1953: James Watson and Francis Crick (clockwise from top left) – guided by X-ray photographs taken by **Maurice Wilkins** and **Rosalind Franklin** – discover double-helix structure of DNA

1961: Marshall Nirenberg deciphers genetic code, revealing sequence of amino acids in protein molecules

1977: Walter Gilbert and Frederick Sanger devise techniques for sequencing order of base pairs

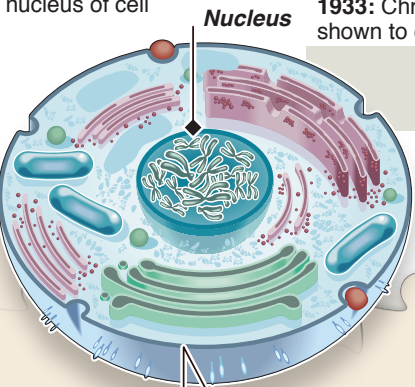
1986: Leroy Hood develops first high-speed automated DNA sequencer



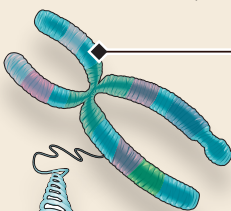
1990: Human Genome Project begins with goal of sequencing nucleotides and mapping all genes in human DNA

June 2000: U.S. President **Bill Clinton** announces that 85% of genome has been sequenced. Research now shifts to discovering how individual genes within chromosomes vary

2006: Sequence of last human chromosome published. Chromosome 1 is largest with 4,316 genes, made up of some 249 million base pairs



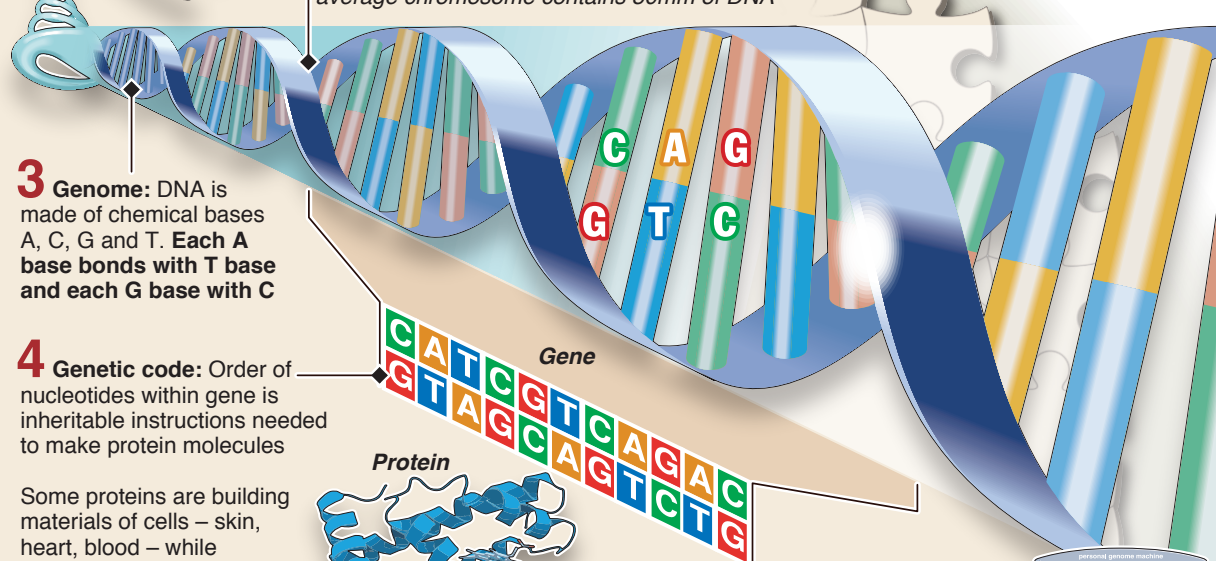
1 Human cell: Nucleus of every cell contains 46 chromosomes, 23 from each parent



2 Chromosome: Each chromosome is comprised of one tightly coiled molecule of DNA with proteins that serve to package DNA and control its functions. **DNA carries unique genetic code that determines characteristics of each person**

DNA: Uncoiled molecule is so large that average chromosome contains 50mm of DNA

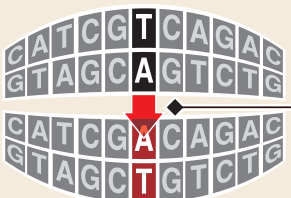
Cost per human genome (2001)
\$95.3 million



3 Genome: DNA is made of chemical bases A, C, G and T. **Each A base bonds with T base and each G base with C**

4 Genetic code: Order of nucleotides within gene is inheritable instructions needed to make protein molecules

Some proteins are building materials of cells – skin, heart, blood – while others control biological processes such as digesting food or carrying oxygen in blood



5 Mutations: Alterations to sequence of code can result in proteins with incorrect form and shape. **Scientists have identified more than 6,000 gene disorders which affect about one in 200 people**

6 Personal genomes: New-generation sequencing techniques may eventually identify risks of genetic diseases and suggest therapies

Cost per genome (2017)
\$1,121

