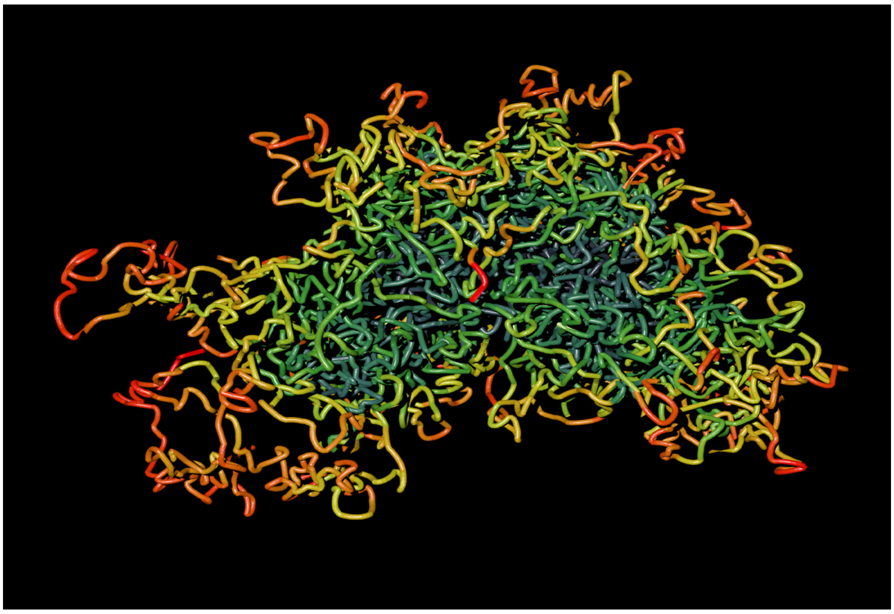
Showing the 3D shape of our chromosomes



The 3D shape of our chromosomes within our cells usually looks very differerent to the classic 'X' shape most people are familiar with. Image: Dr Peter Fraser, The Babraham Institute

An international team of scientists funded by BBSRC have developed a new method for mapping the shape of chromosomes within the nuclei of our cells.

The discovery offers researchers a much better understanding of how a chromosome usually looks in three dimensions inside a cell, during the time when it is performing the majority of its functions.

This allows scientists to map genes and other features onto the 3D structure and to better understand how the folding of DNA and the position of genes affects how our genomes work..

The research was conducted by teams at the BBSRC-funded Babraham Institute, the University of Cambridge and the Weizmann Institute, Israel led by Dr Peter Fraser. The technology was made possible thanks to funding from BBSRC, Medical Research Council (MRC) and the Wellcome Trust.

What did they do?

Dr Fraser's team developed a new method to visualise the shape of chromosomes. It involves taking tens of thousands of molecular measurements of chromosomes inside cells, using the latest DNA sequencing technology.

By combining these tiny measurements using powerful computers they have created a 3D portrait of chromosomes for the first time.

The technique has produced beautiful 3D models that more accurately show the complex shape of chromosomes and the way DNA within them folds up.

Dr Peter Fraser, the Babraham Institute:

"The vast majority of cells in an organism have finished dividing and their chromosomes don't look anything like the X-shape."

"We've created a much more accurate picture of how the DNA folds within a chromosome in its usual state, a state in which all the important functions of the genome are operating and controlled."

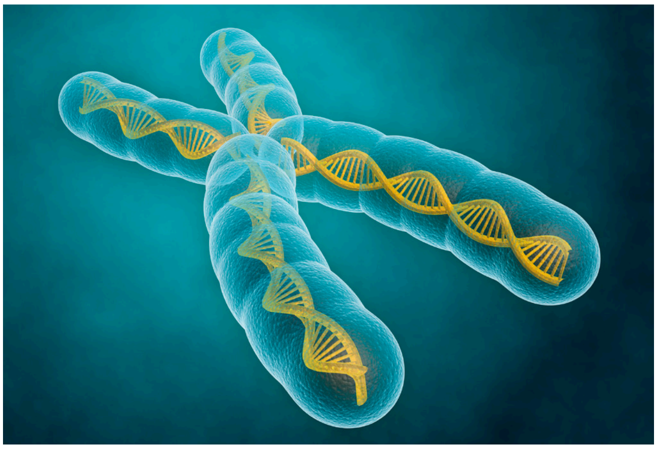
"Using these 3D models, we have begun to unravel the basic principles of chromosome structure and its role in how our genome functions."

Key facts

Between them chromosomes contain all of an species' DNA, within the nucleus of cells

46 The number of chromosomes humans have, in 23 pairs

The 3D organisation of DNA in chromosomes has been linked to a role in controlling almost all genome functions



Chromosomes only look like this for short periods of time when a cell is undergoing division. Image: Thinkstock

Our DNA is organised into chromosomes inside the nucleus of every cell, and most people think of chromosomes as having a distinctive X-shape. In fact chromosomes usually only form this shape when the cell is dividing.

The new method for visualising chromosomes, called Single cell Hi-C, paints a truer picture of the shape chromosomes are in most of the time.

Dr Peter Fraser of The Babraham Institute said: "The image of a chromosome, an X-shaped blob of DNA, is familiar to many but this microscopic portrait of a chromosome actually shows a structure that occurs only transiently in cells – at a point when they are just about to divide.

"The vast majority of cells in an organism have finished dividing and their chromosomes don't look anything like the X-shape. Chromosomes in these cells exist in a very different form and so far it has been impossible to create accurate pictures of their structure.

"Using our new technique we've created a much more accurate picture of how the DNA folds within a chromosome in its usual state, a state in which all the important functions of the genome are operating and controlled."

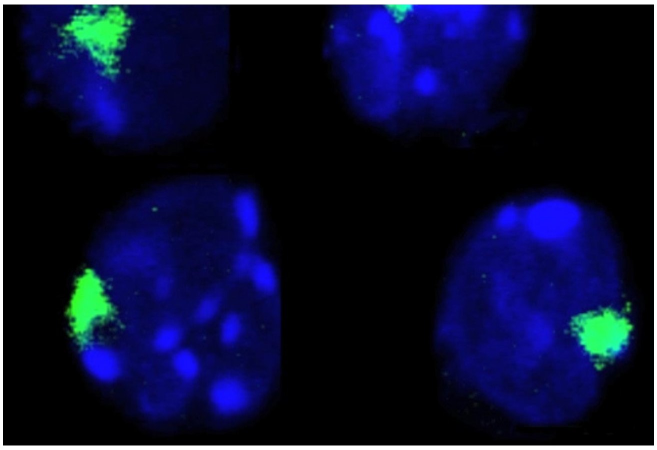
Why is it important?

The structure of chromosomes and the way the DNA within them folds up are intimately linked to when and how much genes are expressed, which has direct consequences for health, ageing and disease.

The 3D organisation of the genome has been linked to having a role in all sorts of vital processes, including gene activation, gene silencing, DNA replication and DNA repair. In fact, just about any genome function has a spatial component that has been implicated in its control.

Dr Fraser added: "These unique images not only show us the structure of the chromosome, but also the path of the DNA in it, allowing us to map specific genes and other important features. Using these 3D models, we have begun to unravel the basic principles of chromosome structure and its role in how our genome functions."

"Single cell Hi-C data bridge current gaps between genomics and microscopy studies of chromosomes and genomes and will help us to understand genome regulation, which is a major contributor in control of health and ageing."



Here the DNA in a cell's nucleus has been stained blue, with one chromosome in green. As you can see it looks nothing like an 'X' shape. Image Drs Takashi Nagano and Peter Fraser, The Babraham Institute

Contact

Babraham Institute press office
Tel: 01223 496230
Email: louisa.wood@babraham.ac.uk
Web: http://www.babraham.ac.uk/contact-us

About BBSRC

The Biotechnology and Biological Sciences Research Council (BBSRC) invests in world-class bioscience research and training on behalf of the UK public. Our aim is to further scientific knowledge, to promote economic growth, wealth and job creation and to improve quality of life in the UK and beyond.

Funded by Government, BBSRC invested over £484M in world-class bioscience in 2013-14. We support research and training in universities and strategically funded institutes. BBSRC research and the people we fund are helping society to meet major challenges, including food security, green energy and healthier, longer lives. Our investments underpin important UK economic sectors, such as farming, food, industrial biotechnology and pharmaceuticals.

BBSRC bioscience for the future