

## What is epigenetics?

The human body consists of more than 200 different cell types. All cells contain the same genetic information – the same DNA sequence – and they are therefore, in theory, able to synthesise the same proteins.

However, each cell type synthesises a specific set of proteins. Nerve cells synthesise proteins that are necessary for generating nerve cells, muscle cells synthesise proteins necessary for building up muscle fibres, etc. This is what makes each cell type unique.

The differences in the protein synthesis result from the activation of some genes and inactivation of others. This specialisation already takes place during early embryonic development and continues throughout life. But how do the cells exercise control over their own development? To a great extent the answer lies in a mechanism for regulation of gene activity called “epigenetic regulation”.

Epigenetic regulation is a question of “opening” the DNA structure and thereby activating the gene – or inactivating the gene by “closing” the DNA structure. This may sound simple but in reality the cell has to condense two meters of DNA inside its 1/100 millimetres-in-diameter body! In the

condensation process, the cell also decides which genes are going to be activated, and which are not – and here a special group of proteins, the histones, plays a central part.

During condensation, the DNA is wound around the histones, which are also able to determine the DNA structure. This happens by attaching a number of complex and relatively unknown combinations of small chemical modifications under the influence of different enzymes. This results in the opening of some parts of the DNA structure and in the closing of others. In this way gene activation, which is specific for each of our distinct cell types, is regulated.

Finally, epigenetic regulation of gene activity is a fundamental mechanism that takes place in all eukaryotic cells – in animals, humans, plants – in the regeneration of tissues, the preservation of stem cells and of the DNA, which contains the genetic material, the genes. At the same time defects in epigenetic gene activity regulation are causally connected to cancer and other serious diseases in human beings.

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