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The melody of epigenetics

David Brocks, a PhD student at the German Cancer Research Center (DKFZ), has developed a method that enables him to make epigenetic differences between cancer cells and healthy cells audible. To do so, he transforms the sequence of special chemical labels on DNA into musical melodies. Changes in this sequence, which is called epigenetic pattern, are reflected in the melodies. The labels in the DNA influence which genes are translated into proteins in a cell. Thus, they also play an important role in the development of cancer.

For this project, Brocks has studied a specific epigenetic mechanism called DNA methylation. This is a process in which the cell attaches methyl groups to individual DNA building blocks and, thus, influences whether the blueprint for a certain protein is available or not. This can have grave consequences for the entire organism: For example, if a particular gene for a growth factor has only a few methyl groups and is consequently very active, this can lead to unlimited cell division and, in the worst case, to the development of cancer. Various factors affect the pattern of methyl groups on the DNA and, in this way, may influence which genes are turned on or turned off. For example, diet is among the factors that can cause epigenetic changes and thus ultimately promote disease.

More and more scientists are presently addressing the exciting research field of epigenetics. Yet in the general public, it is by far less known than genetics. David Brocks, a PhD student at the Division of Epigenomics and Cancer Risk Factors at the German Cancer Research Center (Deutsches Krebsforschungszentrum, DKFZ), wanted to make this complex topic more easily accessible. He has developed a method that transforms the epigenetic pattern of DNA into music.

To this end, Brocks has focused exclusively on sites in the DNA where the cell can attach methyl groups. Across the whole genome, there are about 28 million positions that can be either methylated or not. “The idea was to combine several of these methylation sites in order to generate a greater complexity of music and notes,” Brocks explained. To do so, his approach is to join up fragments of seven potential modification sites. For each of these fragments, there are 2 to the power of 7, i.e., 128 sequences that are theoretically possible. Brocks then matches them with 128 different chords and note variations. Several fragments in a row are a musical reflection of the methylation pattern of the DNA region that is being studied. A specific DNA region that plays a role in the development of prostate cancer is an example of the audible difference between cancer cells and healthy cells: The relevant DNA region “sounds” very different in cancer cells, due to many additional methyl groups, compared to healthy cells, whose DNA exhibits much lower levels of methylation.

Brocks receives positive feedback for his method from around the world. A colleague from Australia, who pursues twin studies, has shown very specific interest. “He asked me whether it was possible to use the musical transformation to compare the epigenetic differences in a set of twins,” Brocks said. While the sequence of DNA building blocks in the genome of monozygotic twins is almost 100 percent the same, their epigenetic patterns exhibit variations due to different environmental influences.

An audio sample of the “epigenetic melody” is available in the DKFZ audio track or in the publication.

www.dkfz.de/de/presse/audio/melodie-epigenetik.mp3

David Brocks: Musical patterns for comparative epigenomics.
Clinical Epigenetics 2015, 10.1186/s13148-015-0127-8

The German Cancer Research Center (Deutsches Krebsforschungszentrum, DKFZ) with its more than 3,000 employees is the largest biomedical research institute in Germany. At DKFZ, more than 1,000 scientists investigate how cancer develops, identify cancer risk factors and endeavor to find new strategies to prevent people from getting cancer. They develop novel approaches to make tumor diagnosis more precise and treatment of cancer patients more successful. The staff of the Cancer Information Service (KID) offers information about the widespread disease of cancer for patients, their families, and the general public. Jointly with Heidelberg University Hospital, DKFZ has established the National Center for Tumor Diseases (NCT) Heidelberg, where promising approaches from cancer research are translated into the clinic. In the German Consortium for Translational Cancer Research (DKTK), one of six German Centers for Health Research, DKFZ maintains translational centers at seven university partnering sites. Combining excellent university hospitals with high-profile research at a Helmholtz Center is an important contribution to improving the chances of cancer patients. DKFZ is a member of the Helmholtz Association of National Research Centers, with ninety percent of its funding coming from the German Federal Ministry of Education and Research and the remaining ten percent from the State of Baden-Württemberg.

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