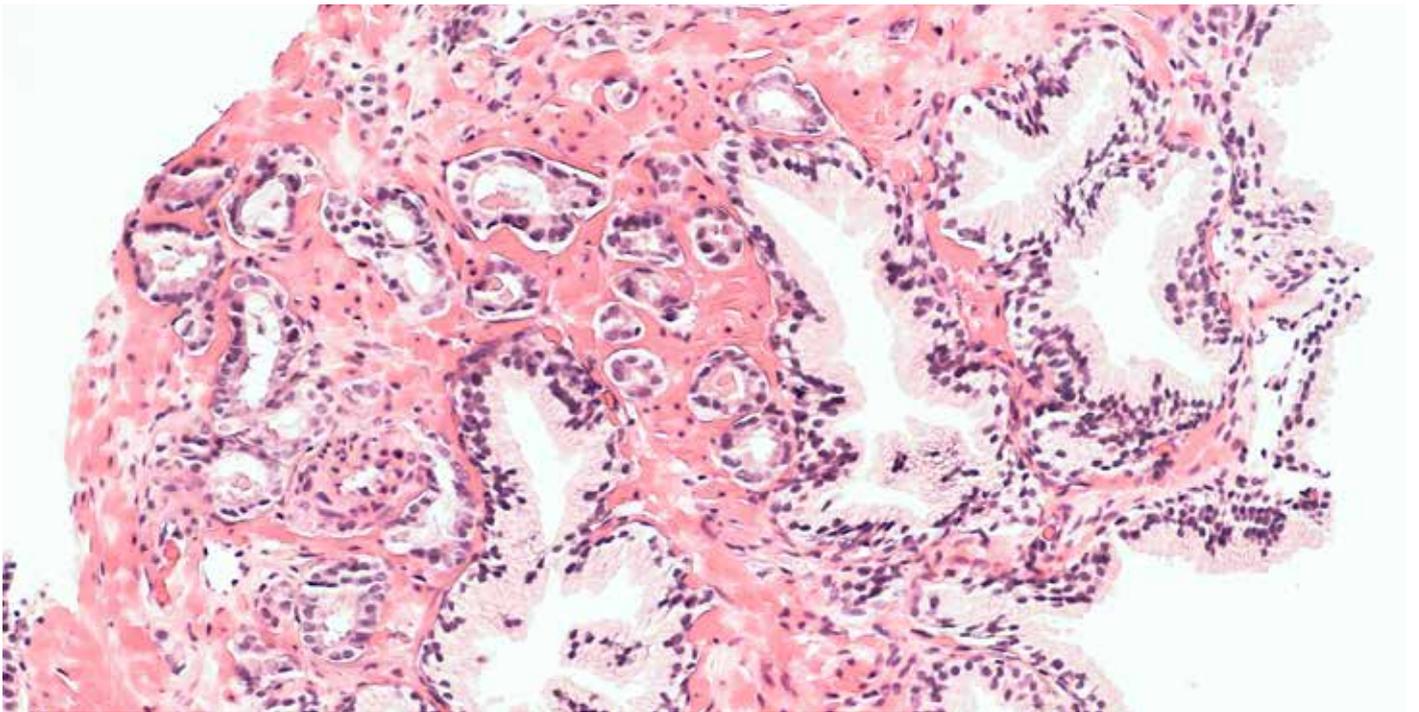# Digital pathology speeds up diagnosis

Digitalisation is revolutionising pathology. Scanners can be used to convert microscope samples into digital format. The scanner captures the sample one view at a time and a computer combines them into a virtual microscopy image.

At Turku University Hospital, pathology samples are digitalised and examined on computer screens. This enables various measurements and AI applications. AI applications developed in cooperation with the Auria Biobank reduce routine work by pathologists and expedite sample analysis.

Markku Kallajoki, Managing Director of Pathology at Turku University Hospital, has done basic cancer-related research based on the study of cell models and cell cultures. He has been a specialist in pathology and Professor of Cellular and Molecular Pathology. One of Kallajoki's special interests is prostate cancer.

Pathologists view a tissue sample under a microscope to evaluate the aggressiveness of prostate cancer. A malignant tumour is given a so-called Gleason score on a scale of 6 to 10. The higher the score, the more aggressive the cancer. A Gleason score of 7 is considered the threshold between good and bad prognoses. High Gleason scores (8–10)

refer to an aggressive tumour and low scores (less than 7 points) to non-aggressive cancer.

"The higher the score, the more aggressive the cancer. Artificial intelligence can identify cancerous areas in tissue samples before examination by a pathologist. It may also suggest a Gleason score. This enables pathologists to focus on providing a second opinion on the sample areas identified by AI. In any case, artificial intelligence facilitates and speeds up the work of pathologists," says Kallajoki.

Researchers from the University of Tampere and the Karolinska Institute in Stockholm have developed an AI-based method of microscopic diagnosis and classification of prostate cancer. 6,600 prostate biopsies were used as a material for teaching artificial intelligence to distinguish between benign and malignant biopsies. A model was created from the samples capable of identifying and quantifying cancer in tissue samples, and classifying its malignancy.

Speeds up analysis by 15%

Studies suggest that 15% of a pathologist's working time is spent on non-diagnostic work. It takes time to find, process, receive and acknowledge samples and referrals. In addition, analysis of samples often requires consultations with other pathologists. Digitalisation reduces the time needed for such consultations, by enabling pathologists to send images online, rather than microscope slides. They can discuss online images on computers in different hospitals, for example.

"Digital pathology eases our work and enhances its quality. It speeds up work and saves money," says Kallajoki.

Digitalisation alone allows a pathologist to analyse around 15% more samples than now. When AI is added, this work could become up to 30% faster.

From sample to digital image

Prostate cancer is the most common malignant cancer in men. It occurs when prostate

cells become malignant. Based on biopsies taken from the prostate gland, a pathologist can estimate the cancer's malignancy based on differentiation of the tumour. The more poorly differentiated the tumour is, the more aggressive the cancer will be.

"A microscope sample is taken if the preliminary clinical examination and findings, laboratory examinations and radiological imaging point to cancer," states Kallajoki.

"Cancer is not cancer until it is confirmed by a pathologist from a cell or tissue sample. If prostate cancer is suspected, a needle is used to take a sample from the prostate gland via the rectum. In most cases, a total of six biopsy samples, one to two centimetres in length and around a millimetre thick, are taken from both sides of the prostate gland. These cylindrical fragments of tissue are sent to a pathology laboratory for the preparation of histological samples."

The need for treatment is assessed based on these histological (microscopic anatomy) samples. The samples are fixed in formalin, increasing the tissue's mechanical strength and preserving it against the destructive effect of the cells' enzymes. Infiltrated with paraffin, the samples are then embedded in paraffin blocks, from which thin slices of three to four micrometres are cut. These are stained with histological dyes and placed between two glass plates. The samples can now be viewed under a microscope and, if necessary, scanned and digitalised.

High-resolution, digitalised tissue samples reveal the same details as when viewed under a microscope. A digitalised image allows the measurement and auto-matic calculation of different cell types. In addition, it is easy to return to the samples, as the images can easily be retrieved from an archive for review, for example at meetings where patients' treatment is being discussed.

Pathologists also learn much from other data. Kallajoki explains that biobanks such as Auria are important. Data is now available from multiple sources, which facilitates the practical work of pathologists. Medical records are a source of patient data, describing the examinations performed and laboratory test results. Imaging data from radiology is also available.

Kallajoki believes new treatments will be developed through the use of data and new methods.

"We are living in exceptional times: cancer treatments are under intense development and new targeted treatments based on molecular changes are forthcoming."

Data storage remains a challenge

"Digital images are huge. The image size is 2–3 gigabytes. An enormous amount of data is created when 12 images are taken of one patient in a single examination. Around 200,000 sample slides are made each year at Turku University Hospital. Because this is medical information, two or three backups are required. Multiply the saving of 200,000 microscopic samples by three, and you get a huge data storage requirement."

Markku Kallajoki explains that the key challenge lies in the fact that the purchase of digital pathology hardware, software and storage systems is planned in different loca-
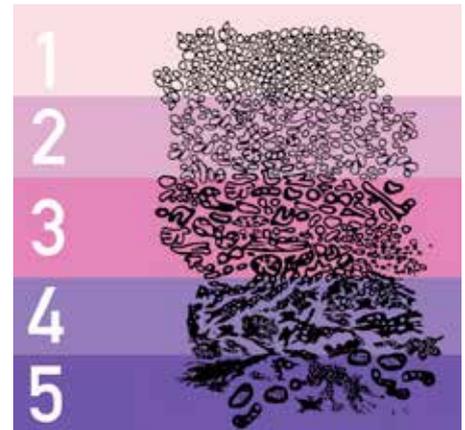
A prostate tumour is given a so-called Gleason score on a scale of 6 to 10. The higher the score, the more aggressive the cancer. Scoring (1–5) is done on the basis of the two most commonly occurring cell images in the samples. A 5 is given for the most aggressive form. If 1 is given, the glands are well formed and small. A score of 5 means that the cell shape and size varies. A Gleason score is obtained by adding together the scores for the most predominant and the most aggressive pattern in the biopsy samples.

tions, but such systems need to be compatible with each other.

"The optimal system would be a compatible, Finnish-wide one. In digital pathology, the largest single cost item is storage capacity."

Ari Turunen