

## Computational pathology: from telepathology to e-learning and diagnostic support in virtual microscopy

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### Abstract

**Introduction:** Telepathology has left its childhood. Its technical development is mature, and its use for primary (frozen section) and secondary (expert consultation) diagnosis has been expanded to a virtual pathology laboratory, which is leaving its technical constraints.

Similar to telepathology, which can be used for e-learning and e-training in pathology, as exemplarily is demonstrated on Digital Lung Pathology (Klaus.Kayser@charite.de) at least two kinds of virtual pathology laboratories will be implemented in the near future: a) those with distributed pathologists and distributed ( $\geq 1$ ) laboratories associated to individual biopsy stations/surgical theatres, and b) distributed pathologists, usually associated to one institution and a centralized laboratory, which digitises complete histological slides. Both scenarios are under intensive technical investigations.

**Description:** The features of virtual pathology comprise a virtual pathology institution (mode a) that accepts a complete case with the patient's history, clinical findings, and (pre-selected) images for first diagnosis. The diagnostic responsibility is that of a conventional institution. The internet serves as platform for information transfer, and open servers such as the iPATH (<http://telepath.patho.unibas.ch>) or DiagnomX ([www.diagnomx.eu](http://www.diagnomx.eu)) for coordination and performance of the diagnostic procedure. Size and number of transferred images have to be limited, and different magnifications have to be used. The sender needs to possess experiences in image sampling techniques, as long as he cannot submit virtual slides. A group of pathologists is "on duty", or selects one member for a predefined duty period. The diagnostic statement of the pathologist(s) on duty is retransmitted to the sender with full responsibility. A centralized virtual pathology institution (mode b) also depends upon the digitalisation of a complete slide, and the transfer of large sized images to different pathologists working in one institution. The technical performance of complete slide digitalisation has already promoted its use in specialized institutions and will probably fulfil the requirements of a conventional pathology institution in the near future.

**Applications:** Virtual pathology can be combined with e-learning and e-training that will serve for a powerful daily-work-integrated pathology system. At present, e-learning systems are "stand-alone" solutions distributed on CD or via internet. A characteristic example is the Digital Lung Pathology CD, which includes about 60 different rare and common lung diseases with some features of electronic communication. These features include access to scientific library systems (PubMed), distant measurement servers (EuroQuant), automated immunohistochemistry measurements, or electronic journals such as Diagnostic Pathology ([www.diagnostic-pathology.org](http://www.diagnostic-pathology.org)) or the former Elec J Pathol Histol ([www.pathology-online.org](http://www.pathology-online.org)). It combines e-learning and e-training with some acoustic support. A new and complete data base based upon this CD will combine e-learning and e-teaching with the actual workflow in a virtual pathology institution (mode a). Other approaches will include automated measurements via the internet ([www.eamus.de](http://www.eamus.de)), automated image quality assessment ([www.diagnomx.eu](http://www.diagnomx.eu)) and automated diagnosis assistance based upon information acquisition of microscopic images ([www.diagnomx.eu](http://www.diagnomx.eu)). In aggregate, a complete new landscape in diagnostic pathology is arising at the horizon.