



Digital Pathology and AI in Histology

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9 September 2025

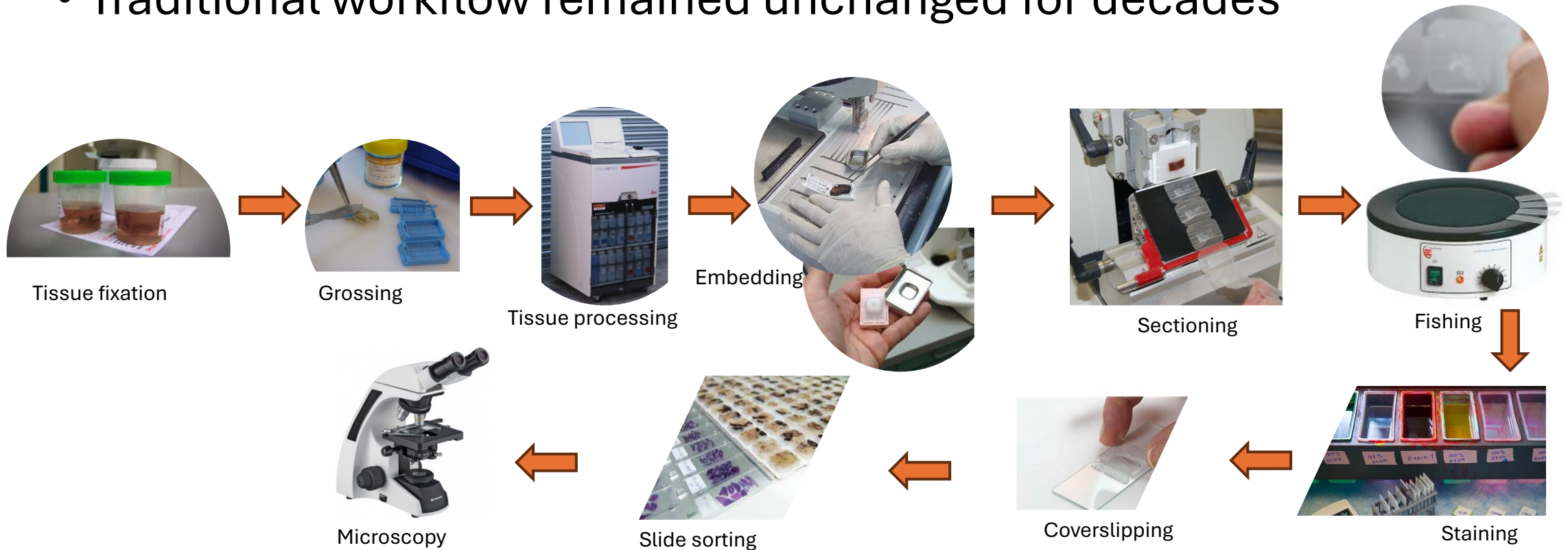
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- Introduction
- Key components and requirements
- Benefits
- Barriers and challenges
- PIL's experience in DP and AI
- Next steps and conclusion

Introduction

Histology – microscopic study of tissues and cells

- Traditional workflow remained unchanged for decades



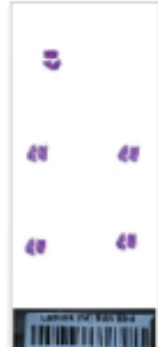
Histology – then and now

- Pathologists using glass slides and microscope to examine tissue
- Limitations:
 - manual handling and transportation of slides- high risk of lost, damaged or misplaced slides
 - difficult access to expert pathologists for labs at different locations or geographically remote and resource-restricted areas,
 - inefficiency of physical slide storage and retrieval system – will take time

What is Digital Pathology?

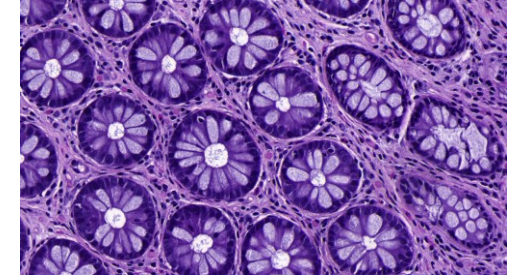
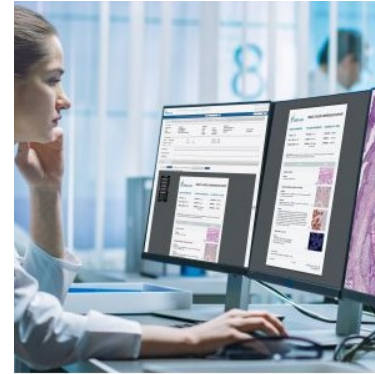
Definition: High resolution digitization of histology slides

- Transforms traditional microscopy into digital workflows
- Enable faster diagnosis, improve workflows, allow AI integration and promote collaboration



Traditional Microscopy

- Requires microscope to view
- One slide at a time
- Limited to manual analysis
- Challenges with archival and retrieval
- Remote viewing not possible
- Standalone, not integrated with LIS
- Looking at a piece of puzzle at one time



Digital Pathology

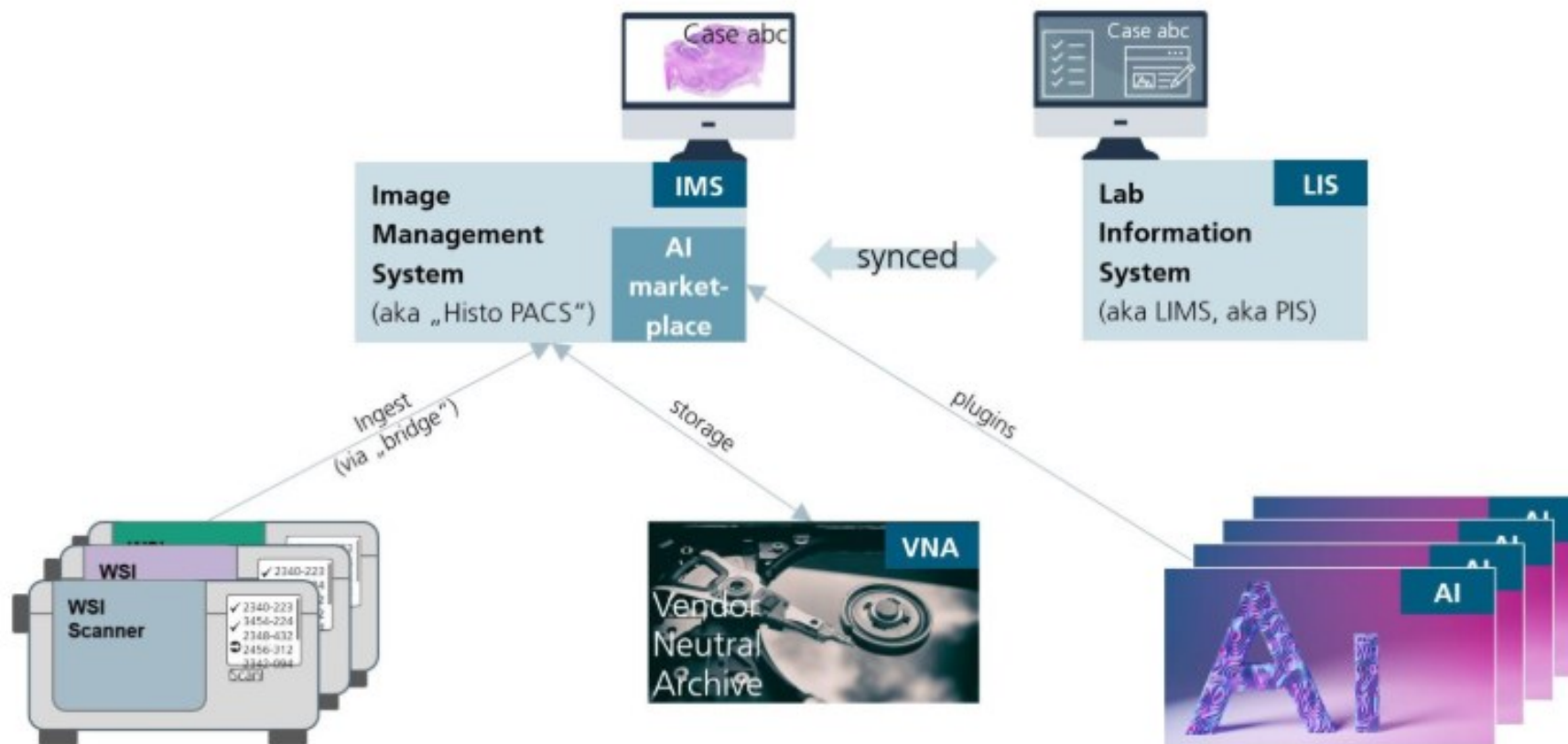
- Viewing via computer monitor
- Multi-slide integrated viewing
- Options to analyse with software algorithms
- Instant archival and retrieval
- View images anywhere, anytime
- Possible to be integrated with the LIS (to access full patient data)
- Supports consolidated viewing

Key components of Digital Pathology:

- Hardware
 - Whole Slide Image (WSI) scanner for image acquisition
 - Workstation for viewing and management of digital images [high computing power]
- Software
 - Image Viewer
 - Image Management System
 - Decision support tool (AI algorithm)
- IT infrastructure
 - Network connectivity –high speed internet for live view and transmission of images
 - Robust storage and server solution [digital image file size: 0.5 GB – 2 GB, dependent on tissue size]
 - Integration with Laboratory Information System [LIS]

Image Management System

A simple overview of a Digital Pathology IT ecosystem could look like this:



By Indica Labs

Virasight by  Virasoft



PathPresenter®



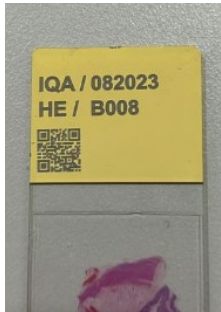
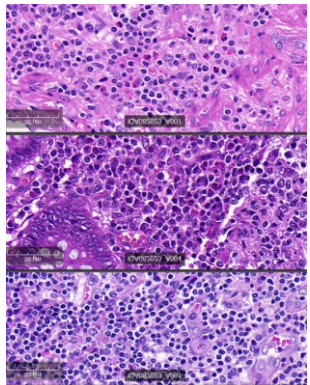
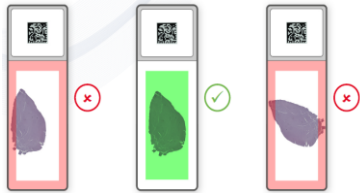
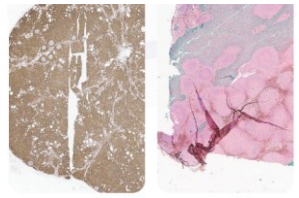
Benefits of Digital Pathology

- Easier and faster delivery of cases
- Allow pathologists to review digital images remotely and refer cases to other colleagues
 - Sick or vacation leave
 - For second opinion consultation from experts
- Prepare the lab to adopt more AI-based diagnostic assessment tools in the near future.
 - Enable pathologists to use image analysis and machine learning tools to assist in diagnosis, providing more accurate and consistent results
- Workflow standardisation
 - improve workflow, eliminating simple error and increase reproducibility compared to conventional method.
- Enable collaboration – MDT meeting & research projects

Barriers and challenges to adoption of DP

- High investment in initial setup and deployment
- Workflow modification required in Histology lab to produce digital ready slides:
 - Good preparation of slides is critical for successful image acquisition and interpretation.
- Technical challenges
 - Hardware and software related, integration with LIS
- Validation of system before use in clinical setting
- End-user readiness and willingness to adapt
- Support from all related parties – IT, management, finance
- Data privacy and security concerns

Figure 1: Best Practices & Impact of Digital-Ready Slides



Digital Pathology Workflow Stage

Digital-Ready Slides Best Practices

Digital-Ready Slides Impact

Embedding

- Cluster samples
- Align samples

Optimizes scan time

Minimizes file size

Supports optimal focus

Microtomy

- Minimize tears, folds, contamination and chatter in slides
- Keep section thickness to 3–4 microns in a single focal plane

Supports optimal focus

Reduces under- or over-calling

Tissue Placement

- Place tissue centrally on the slide
- Avoid “no scan zone” on the edges of the slide
- Know direction of scanning

Optimizes scan time

Minimizes file size

Supports optimal focus

Slide Labeling

- Rule of thumb: >100 slides daily needs barcoding
- Specialized image management & viewing software
- Integrate with laboratory data system (LIS/LIMS)
- Automate association of slide data and WSIs
- Enable slide aggregation into slide sets

Proper labeling avoids issues like over-sized slides and jamming

Leverages LIS/LIMS benefits
Alleviates manual steps & frees staff

Minimize data error risk associated with manual workflow

Staining

- Standardize staining protocols to remove variables & support digital pathology features like multi-slide review
- Set a protocol for post-stain washes to keep slides free of debris & artifacts

Optimizes scan time & minimizes file size

Provides consistency for AI and image analysis

Supports optimal focus & contributes to confidence in manual on-screen review

Coverslipping

- Strongly consider automated coverslipping

Eliminates bubbles on the slide

Mitigates excess mounting media

Supports clean, dry slides



Implementation of Digital Immunohistochemistry (IHC) service in Histology lab

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Premier Integrated Labs - Footprints



1997

Established

36

- 28 hospital based
- 08 stand-alone

Accreditation

ISO 15189, CAP, (MSQH and JCI)

Clientele

- IHH owned hospitals
- Non IHH hospitals & GP Clinics
- Public agencies & institutions
- Corporate clients & walk-in

Served over
4,000
physicians

- IHH owned hospitals
- Non IHH hospitals & GP Clinics
- Public agencies & institutions
- Corporate clients & walk-in

More than
30 million

Tests performed
by PIL per annually
on average

900+

Employee:

- 11 resident pathologists
- 300 MLS & MLT

Background

- PIL has 36 labs in Malaysia [9 with Histology facilities].

No	Histopathology Lab
1	Pantai Hospital Kuala Lumpur
2	Gleneagles Kuala Lumpur
3	Prince Court Medical Centre
4	Pantai Hospital Ipoh
5	Gleneagles Penang
6	Pantai Hospital Ayer Keroh
7	Gleneagles Medini Johor
8	Gleneagles Kota Kinabalu
9	Timberland Medical Centre

- There are **11** resident pathologists and **20+** visiting pathologists, covering all specialties in Histopathology, Cytopathology, Haematology, Chemical Pathology, Cytogenetics, Molecular diagnostics and Medical Microbiology.

Immunohistochemistry (IHC) stain

PIL PHKL Histology Lab (HQ) is processing in the region of 45,000 IHC slides per annum [~150 IHC slides/day].

- Using 4 fully automated stainers: 2 Benchmark Ultra & 2 Dako Omnis
 - Running 170+ IHC markers
- Currently, only 'urgent' IHC slides are being scanned for digital slide viewing
 - PIL is in the process of implementing full digitisation of all IHC slides for outstation (non-Klang Valley) branches.
- 2 scanning devices currently available at PHKL, Bangsar:
 - 3dHistech Scan II [150 slides in 6 racks of 25 slides]
 - Roche DP200 [1 rack of 6 slides]

WORK-FLOW COMPARISON FOR IHC: DP vs Non-DP [conventional]



Review slides by Pathologist
using microscope

1-2 days

Packing of stained slides
Slides are packaged and delivered to respective branch

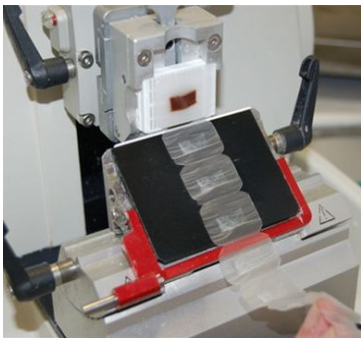
Non-DP (Conventional)

Immunohistochemistry Staining using Ventana BenchMark Ultra and Dako Omnis Autostainer

~ 170+ IHC markers

Preparation of unstained slides
Tissue blocks are sectioned using microtome

4 µm tissue section on special adhesive glass slide



DP

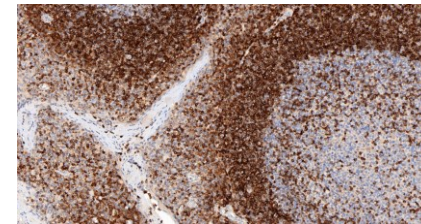
WSI scanner
1. 3dHistech Scan II Digital Pathology Slide scanner (150)
2. Roche Ventana DP 200 (6)



< 1 day

Case assignment
1. 3dHistech Case Center
2. UPath Slide Viewer

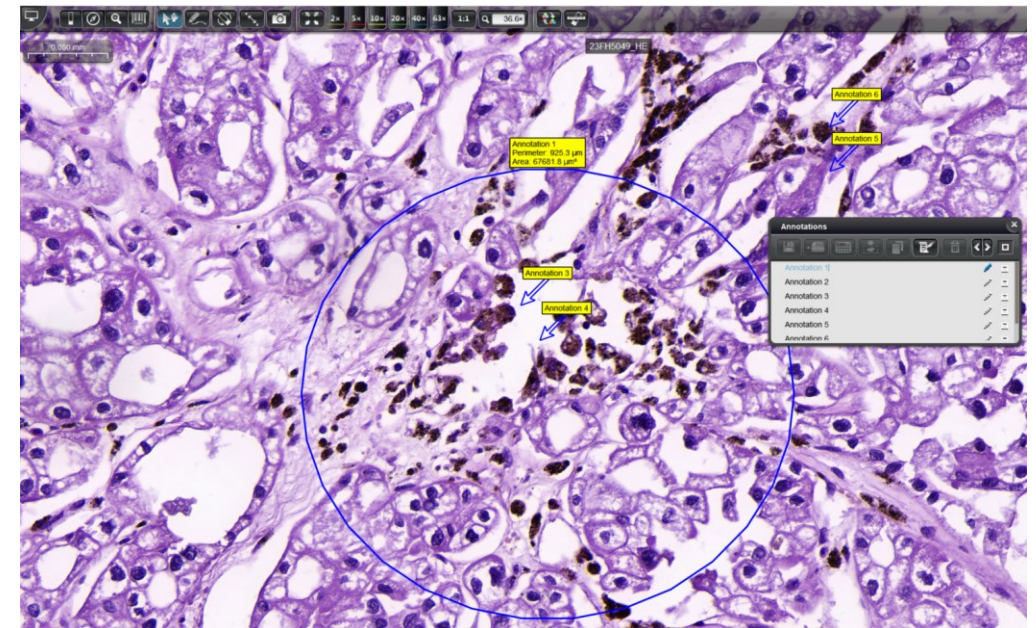
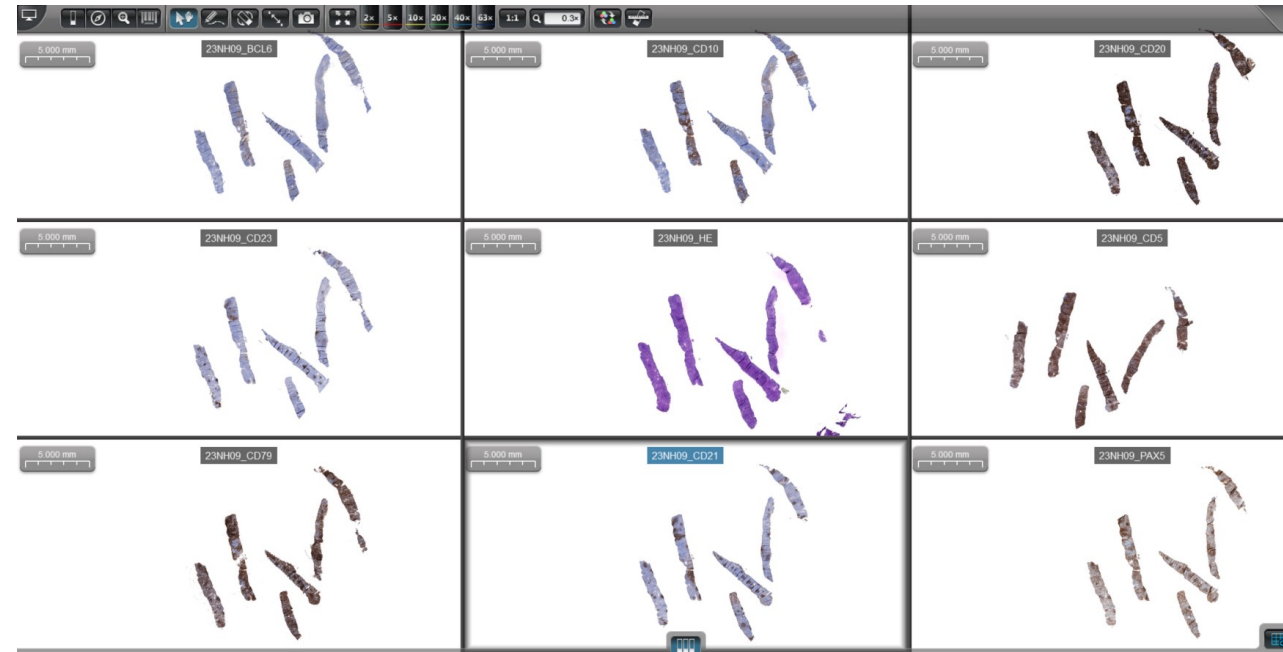
Review WSIs by Pathologist
remotely



WSIs: Whole slide images

Advantages of digitising IHC stained slides

- Able to assess and analyse **multi-slide** digitally
- Able to **annotate** significant ROI to the cellular level and **perform measurement, take snapshots**
- IHC assessment now is becoming increasingly complex & time consuming
 - **AI tool to interpret IHC** would be useful to support pathologists



***ROI** – Region of interest

PIL's involvement in projects related to AI tools for histopathology

1. Ki-67 scoring and AI-powered mitosis detection in the histopathologic evaluation of breast cancer cases.
2. IHC HER2 AI solution
3. Development of AI tool for histologic grading

DP transformation journey in PIL – where are we?

- Early implementation stage (PHKL)
 - Introduced automation at possible steps in the workflow
- Not using DP for primary diagnosis yet
- Progressive implementation -adopting stepwise approach – to address challenges as they arise
 - Histo: starting with IHC and SS
 - Cyto: starting with LBC
 - Continuous validation with additional application as per CAP guidelines

Next steps

- To implement DP in East Malaysia (Kuching), northern region (Penang), southern region (JB) for following services:
 - LBC pap screening
 - To accommodate prospective volume growth without increasing manpower
 - PHKL Bangsar Cytology team can cover for other branches that are experiencing manpower issues
 - Frozen section consultation*
 - Telepathology consultation*
 - *1. Allow pathologists to work remotely, may result in laboratory and office space savings
 - 2. Assist to manage pathologists' coverage and workload redistribution due to sick leave or vacation leave
- Harmonization / Integration with Laboratory Information System (LIS)

Continuous monitoring to ensure sustainability

1. Track performance

- Monitoring TAT and diagnostic accuracy
- User satisfaction
- Identify workflow bottlenecks, troubleshooting common issues

2. Maintain and upgrade

- Regular scanner and software maintenance
- Budget for upgrades and storage expansion [system selected must be scalable]

Conclusion

Adoption of Digital Pathology and AI requires:

- Thorough planning from the beginning
- Careful selection of key components
- Commitment from all parties involved
- Continuous training, monitoring and optimization



Thank you