

NOVEMBER 2025

Oyster MSX Pipeline

A Human - in - the - Loop System
for Accelerating MSX Diagnosis
in Oyster Histology

BY JONATHAN E. ZUL LUNA



Mentors:

Dr. Kristina Kupferschmidt, Dr. Andrew Godbout, Dr. David Gromann



The Economic Engine

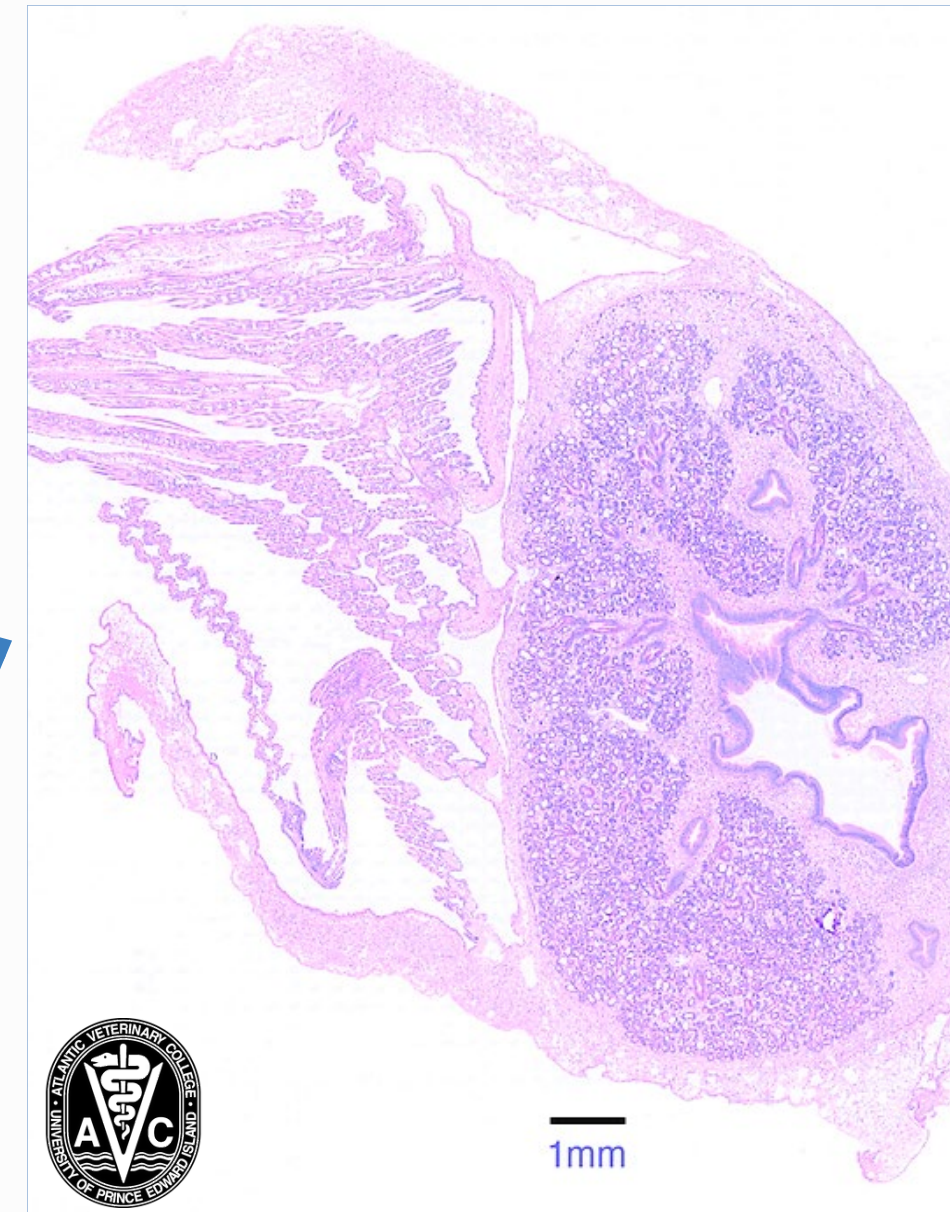
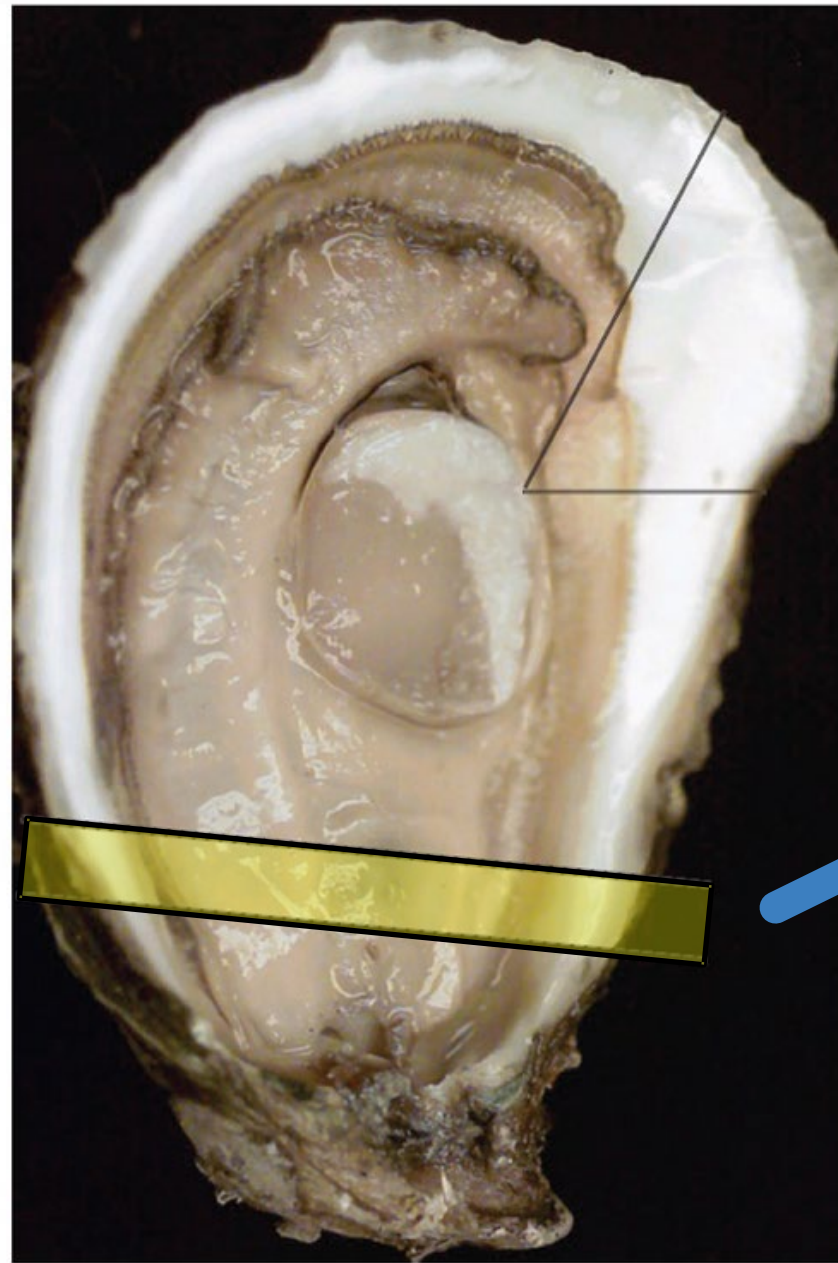
PEI's Oyster Aquaculture Industry

- A Key economic driver for the province, valued at over **\$24 million** annually.
- Supports hundreds of jobs in rural and coastal communities.



From Oyster to Image

Creating the Histology Slide

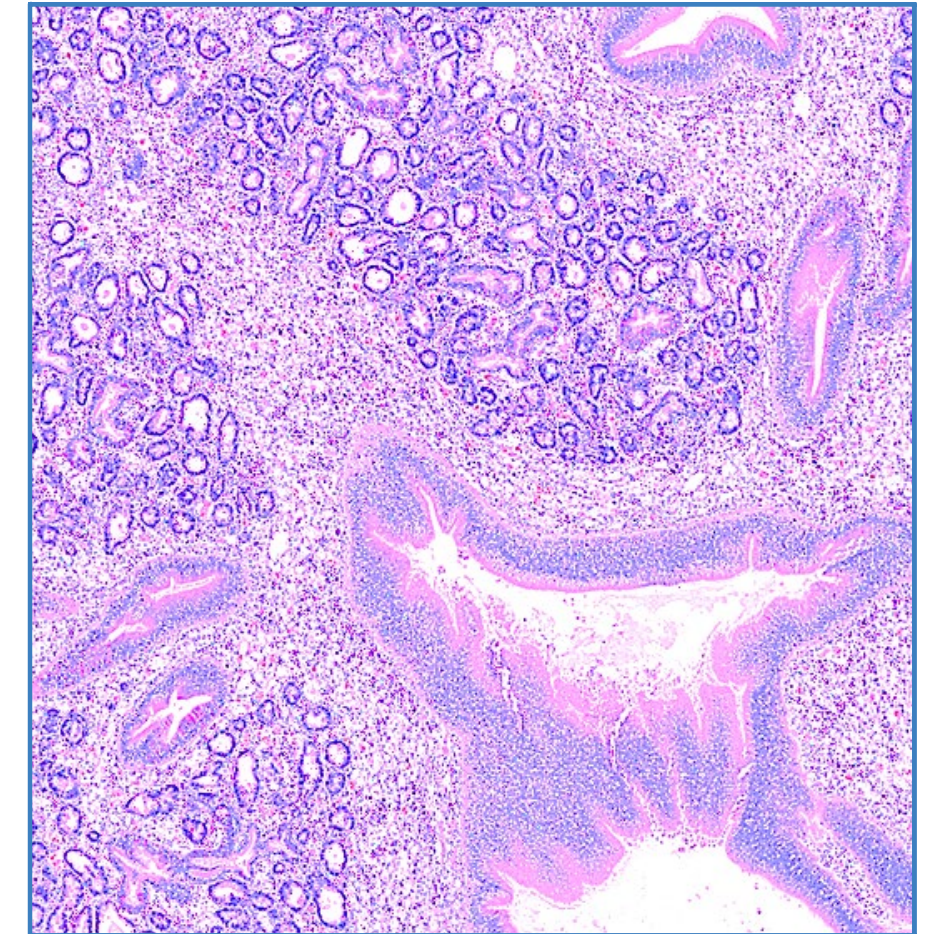
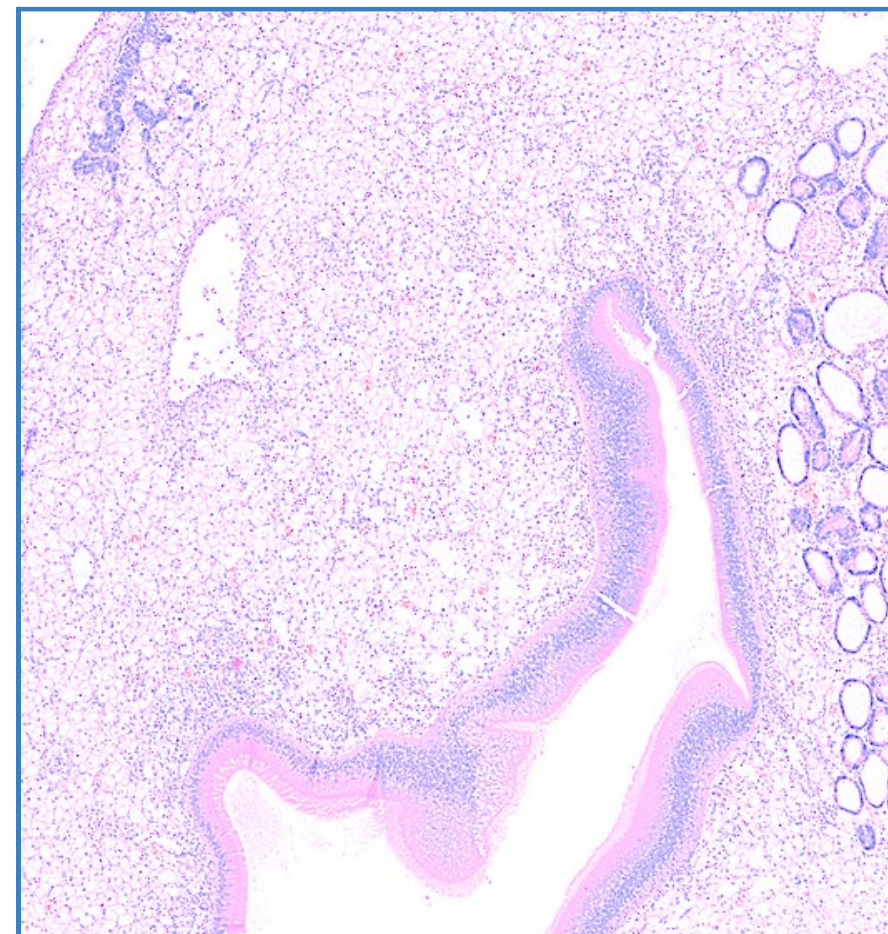
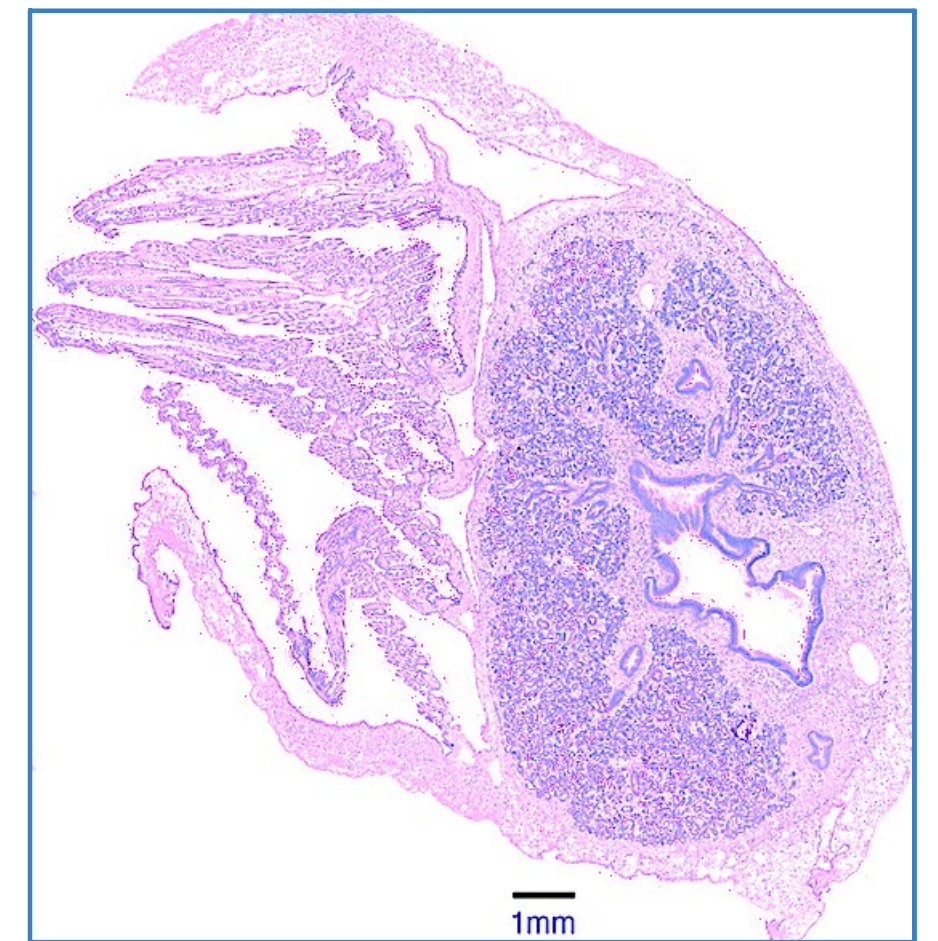


A thin cross - section of the entire oyster is processed and stained to make cellular structures visible under a microscope.

A Microscopic Threat

The MSX Parasite (*Haplosporidium Nelsoni*)

- A protozoan parasite that causes Multinucleated Sphere X (MSX) disease.
- Leads to severe tissue damage and high mortality rates in infected oysters.
- Early and accurate detection is the only way to manage its spread and protect the industry.



Healthy Oyster Tissue

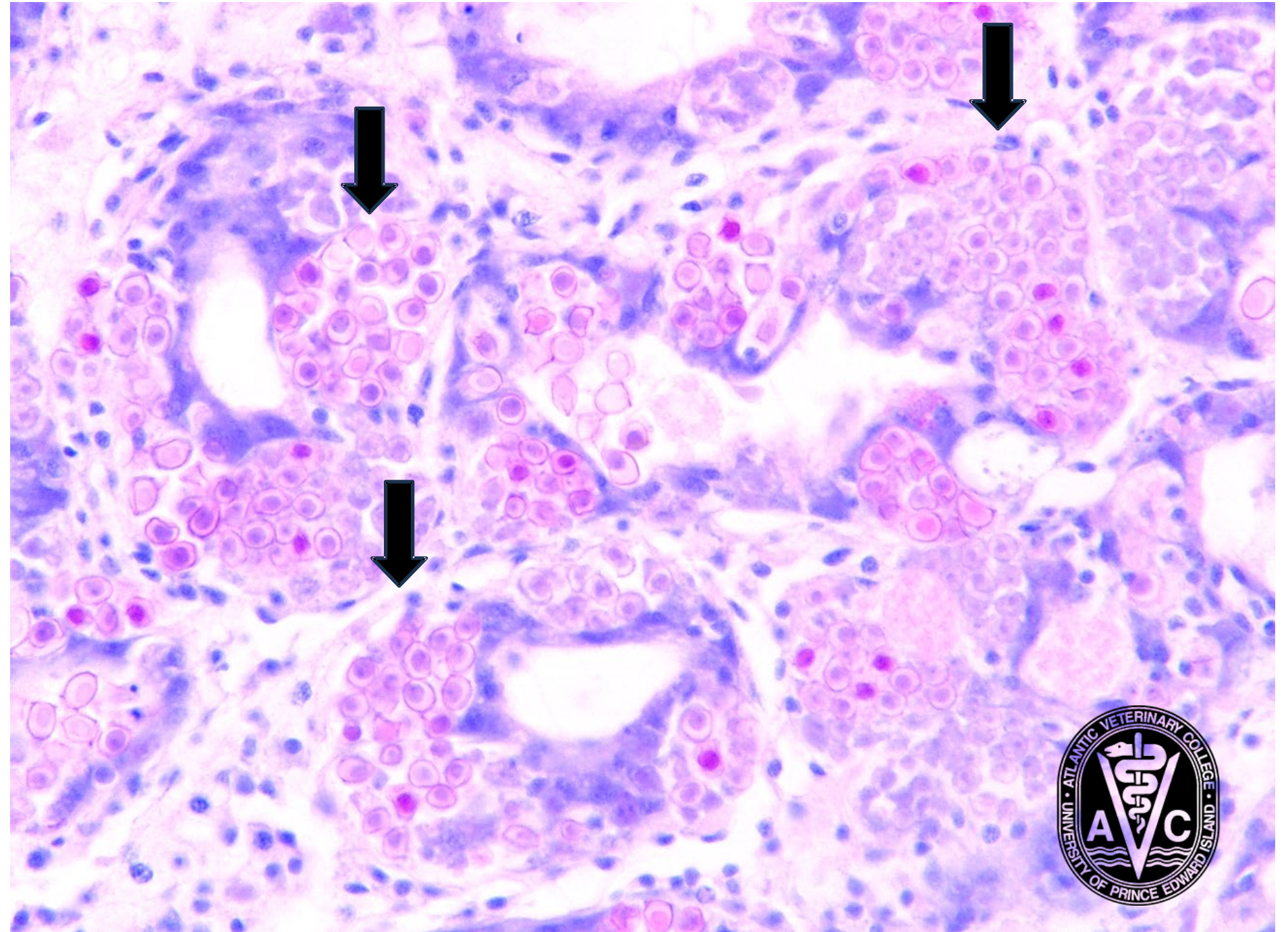
MSX- Infected Tissue



A Microscopic Threat

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A high - m a g n i f i c a t i o n v i e w s h o w i n g m u l t i p l e **sporocyst clusters** (arrows) of the MSX parasite, surrounded by the oyster's intense **inflammatory response** .

The Diagnostic Front Line

The Role of the Atlantic Veterinary College (AVC)

- The AVC is the primary centre for histology - based diagnosis in Atlantic Canada.
- Histology is the gold standard for assessing disease severity, unlike other methods (e.g., PCR).
- Diagnosis relies on manual slide review by a small number of trained pathologists.
- This process is time - consuming, costly, and creates a significant workflow bottleneck.



The Data Challenge

Building a High - Quality Dataset from Scratch



The Paradox: To build a tool that saves expert time, we first need a large investment of that same limited expert time.

The Strategy

A Human - in - the - Loop
Workflow for Pathology

Stage 1: AI Pre - Analysis



The pipeline performs a first - pass analysis, generating initial annotations on a new slide.



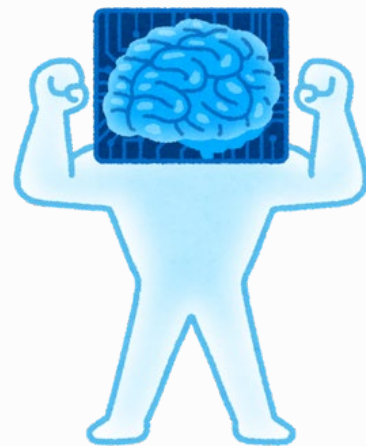
Stage 2: Expert Review



A pathologist quickly validates and corrects the AI's suggestions, saving valuable time.



Stage 3: Model Retraining



The validated annotations are used to improve the AI model, making it smarter with each cycle.



The First Hurdle

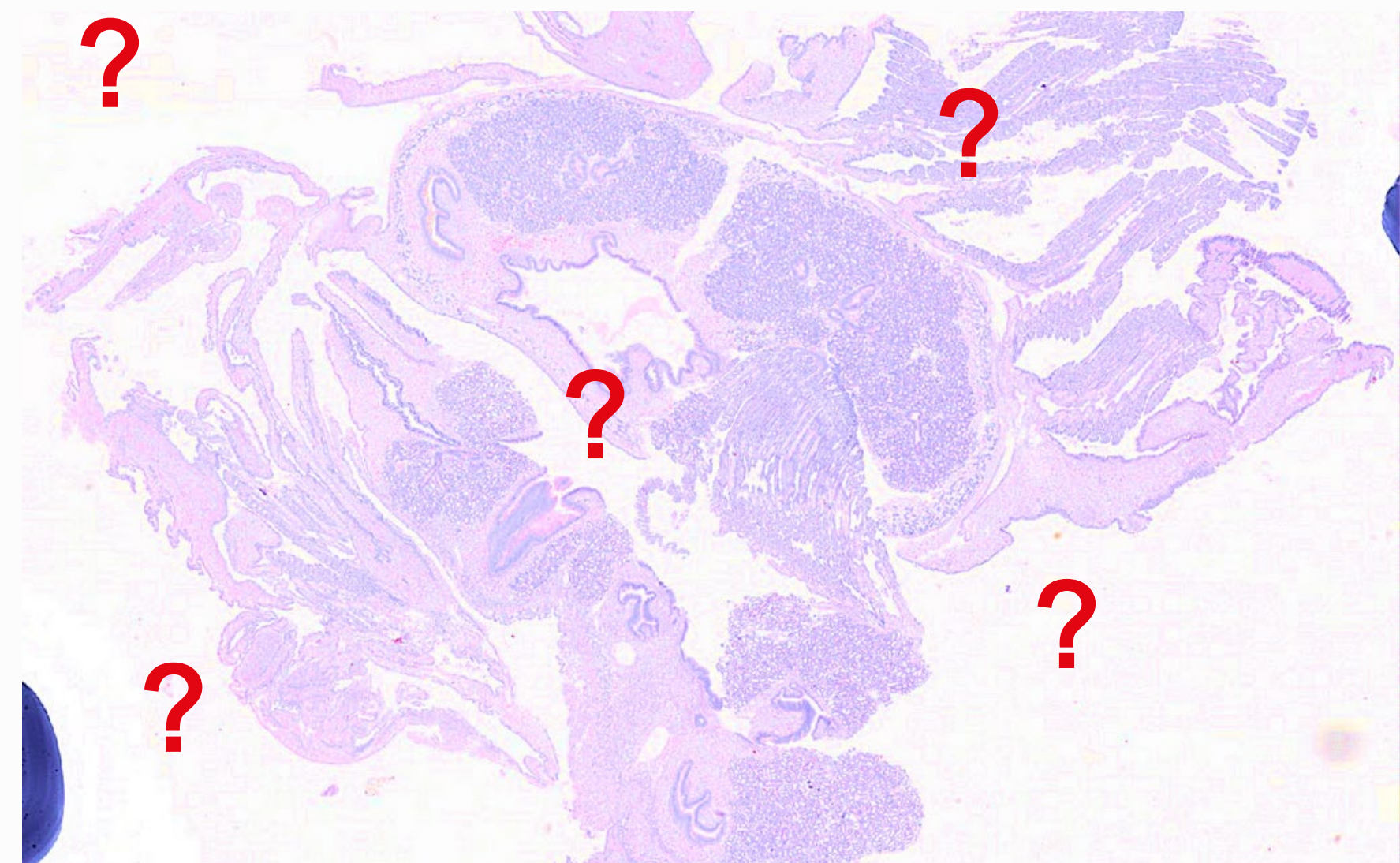
Robustly Separating Oyster Sections

Challenge: How can we create a single, automated process that works reliably for both of these cases without manual intervention?

The Ideal Case



The Common Reality

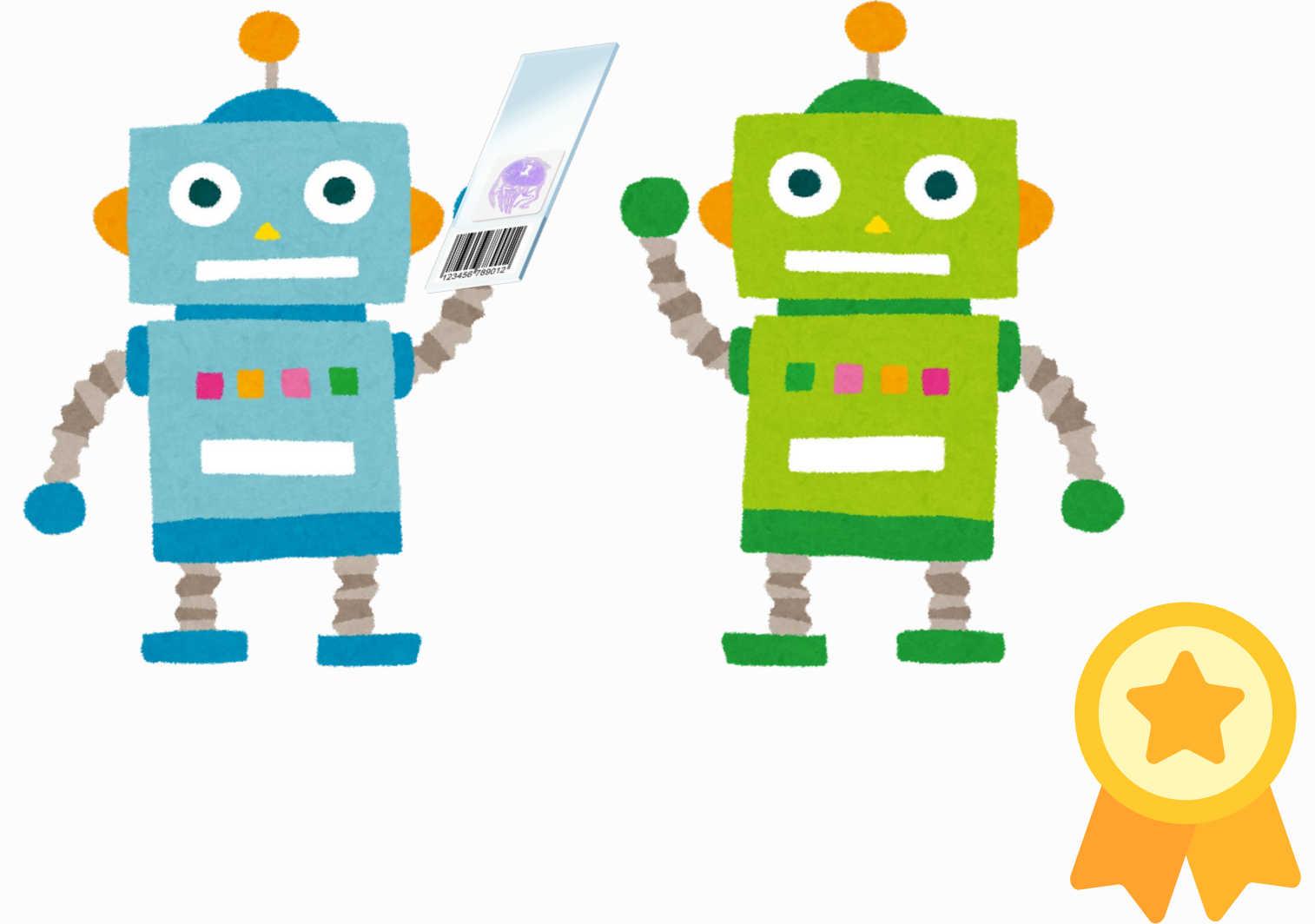


Finding the Right Technology

A Comparison of AI Approaches

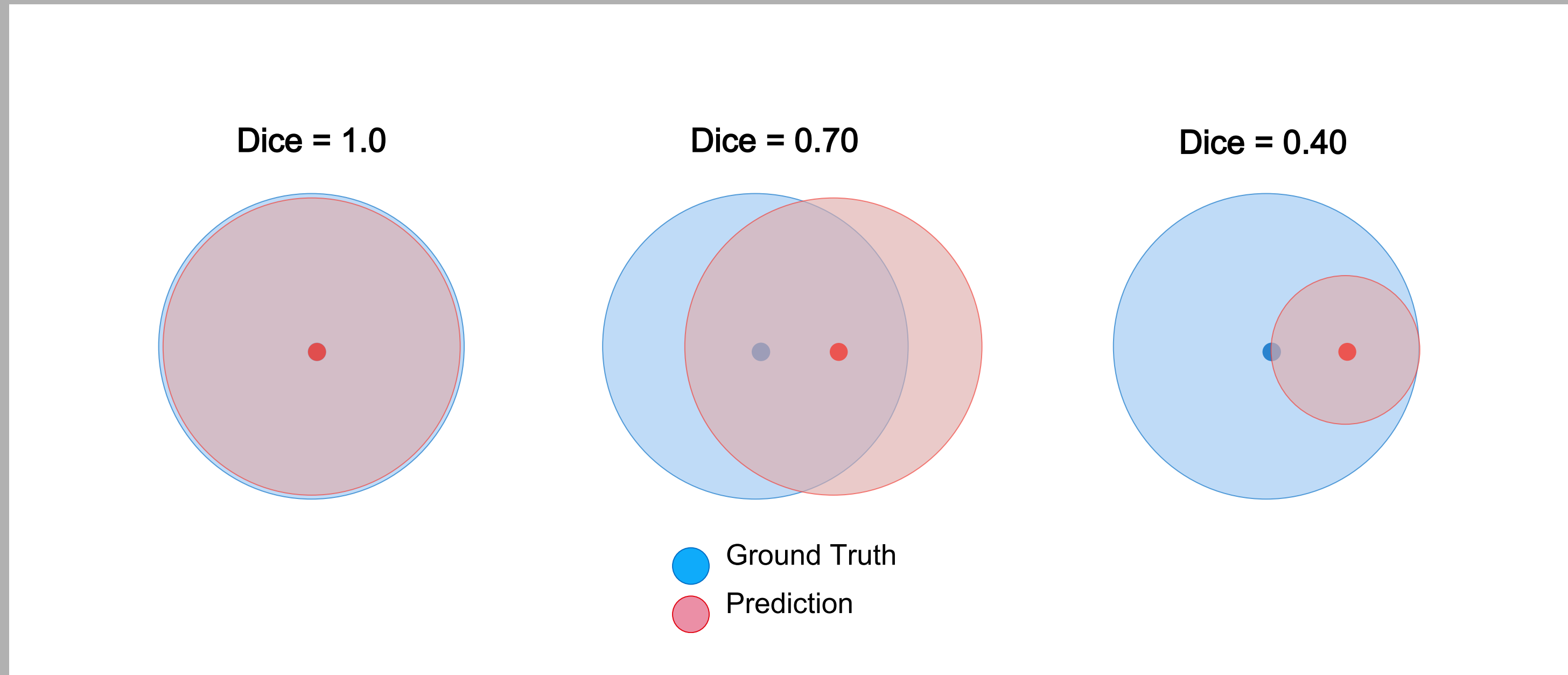


Rigorous
Testing




Finding the Right Technology

A Comparison of AI Approaches



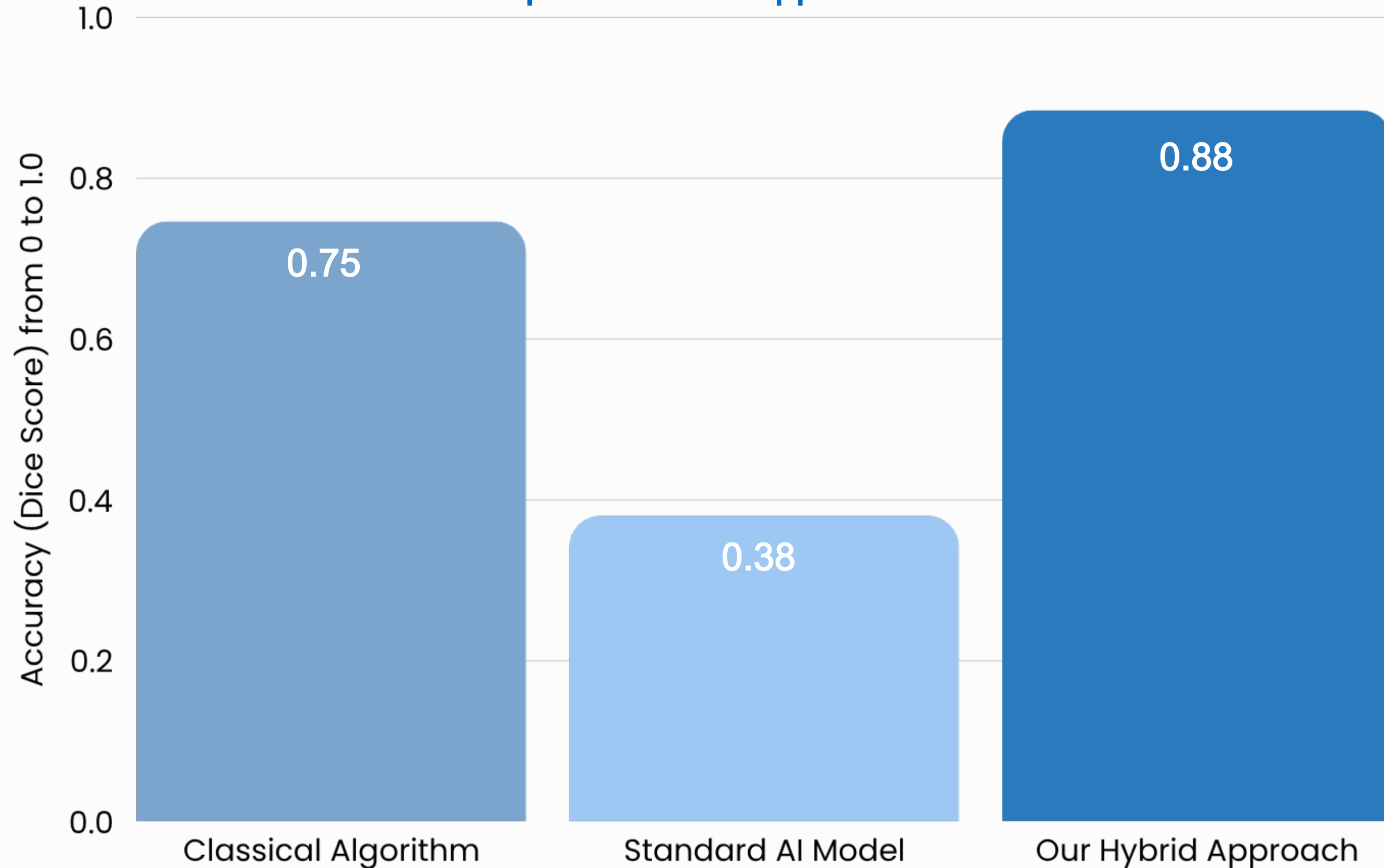
Finding the Right Technology

A Comparison of AI Approaches

| Approach | Methodology | Key Finding | Avg. Dice Score |
|---|-----------------------------|--|--------------------|
| Classical CV | Thresholding & Watershed | Brittle & Parameter - Sensitive. Fails on complex slides and requires constant manual tuning. | 0.7463 ± 0.1287 |
| U- Net | Supervised Deep Learning | Data Starved. The model was limited by the small dataset, leading to poor generalization. | 0.3801 ± 0.1104 |
|  SAM | Promptable Foundation Model | Most Robust & Data - Efficient. Intelligently handles fragmentation and leverages pre - trained knowledge. | 0.8846 ±0.0600 |

Finding the Right Technology

A Comparison of AI Approaches

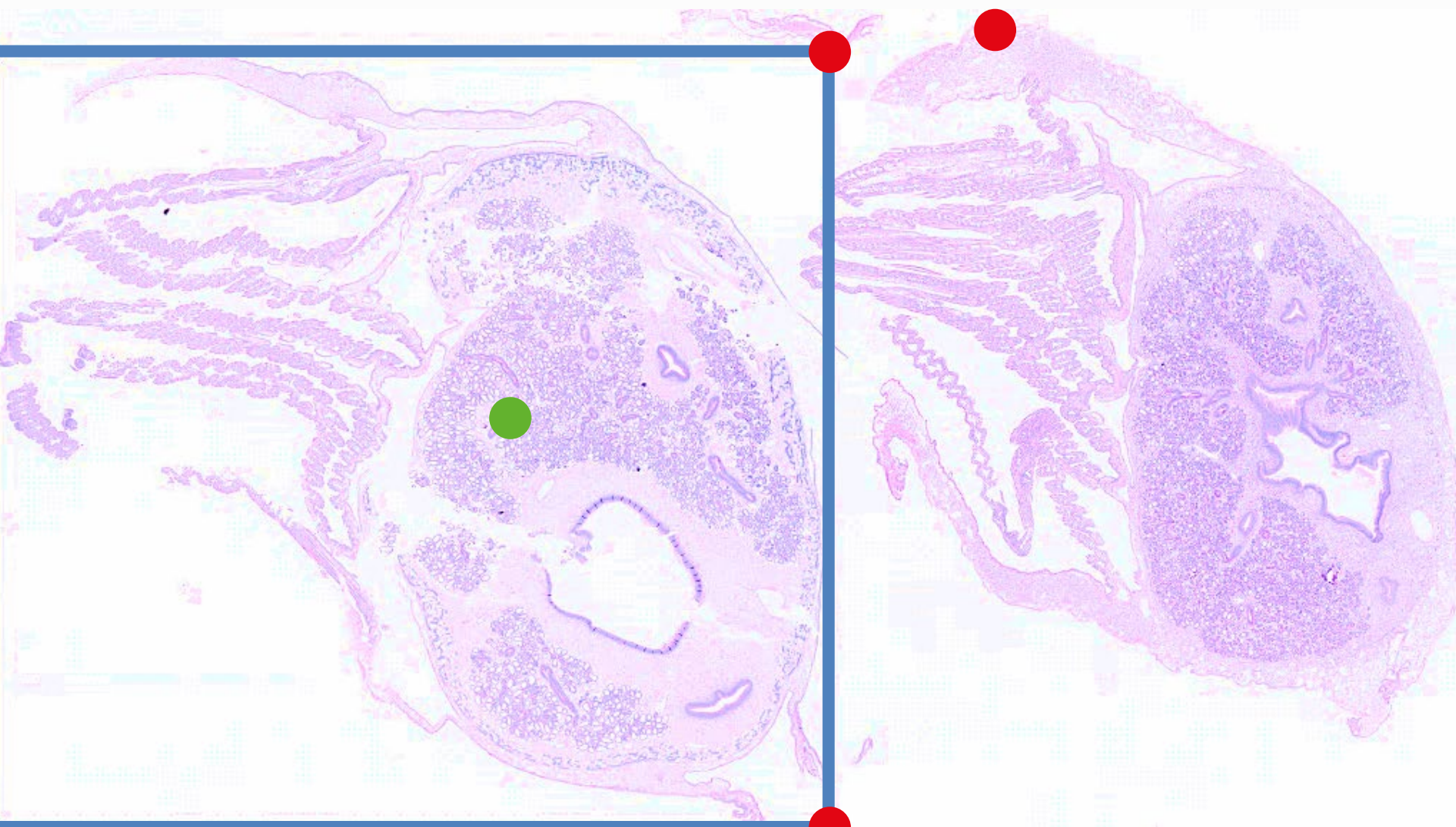


The Solution

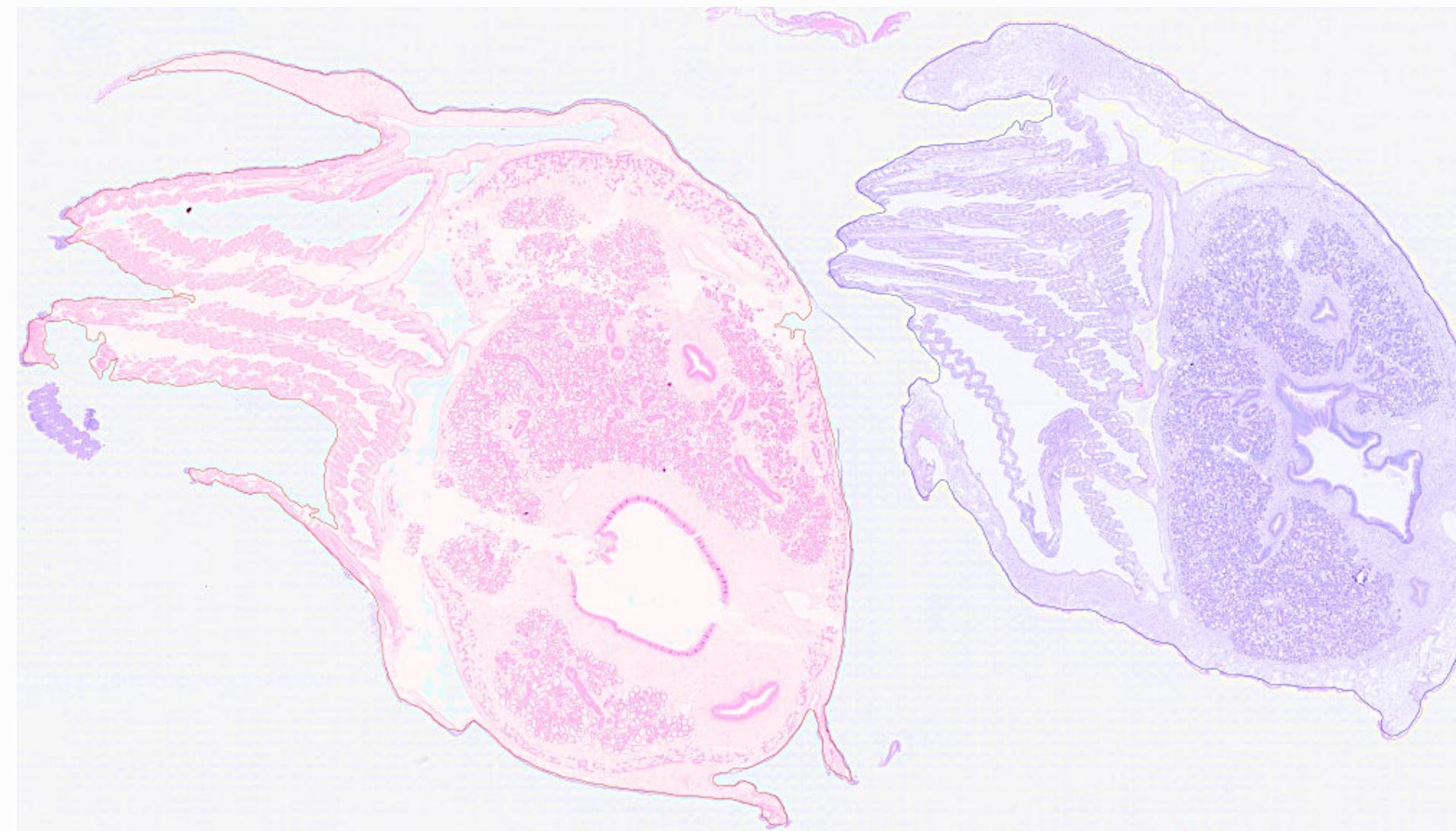
A Hybrid Pipeline for Intelligent Prompting

This hybrid strategy uses a simple, reliable method to answer 'where,' and the powerful foundation model to answer 'what.'

Step 1: Generate Robust Prompts (CV)



Step 2: Precise Segmentation (SAM)



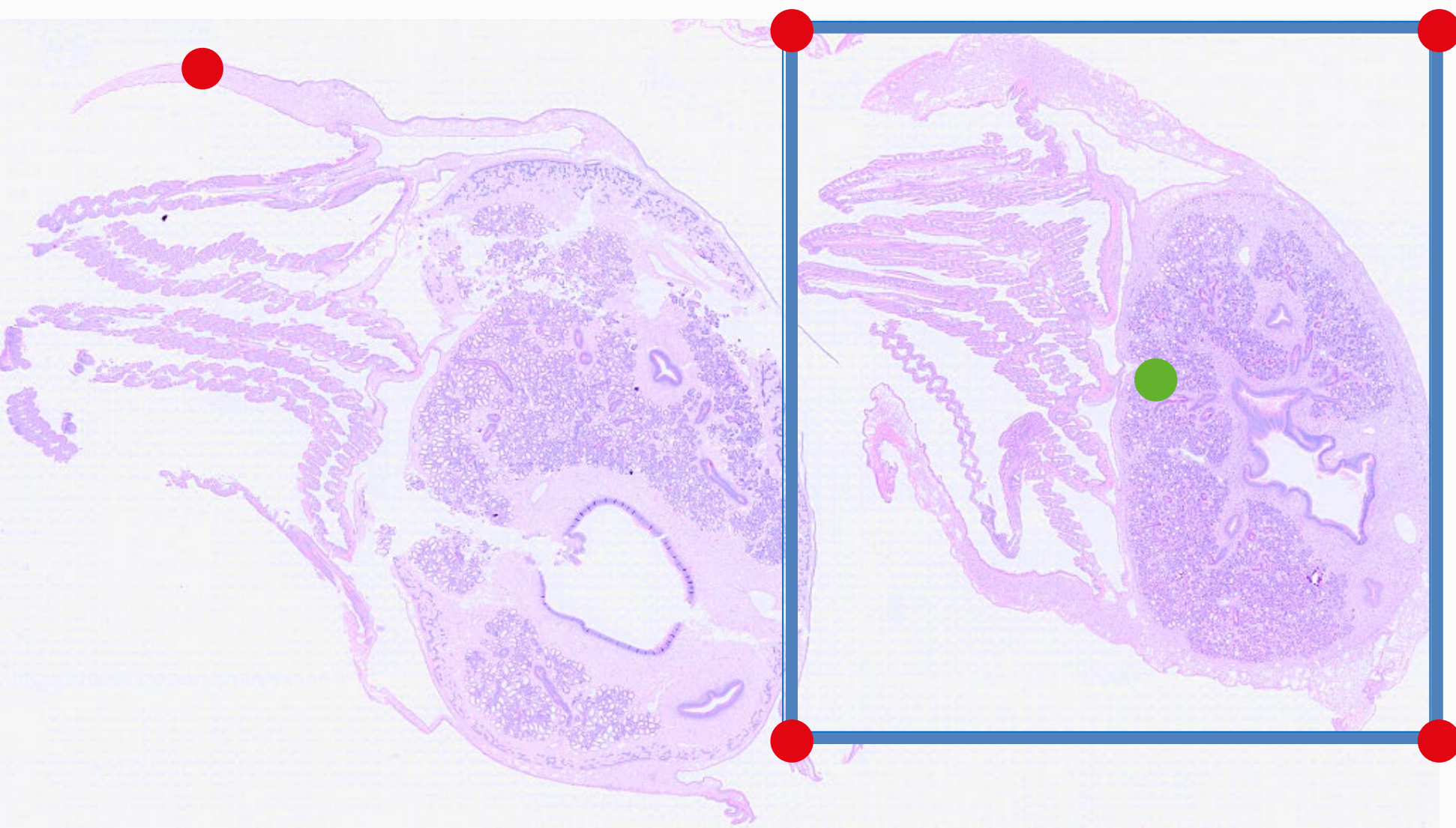
The Solution

A Hybrid Pipeline for Intelligent Prompting

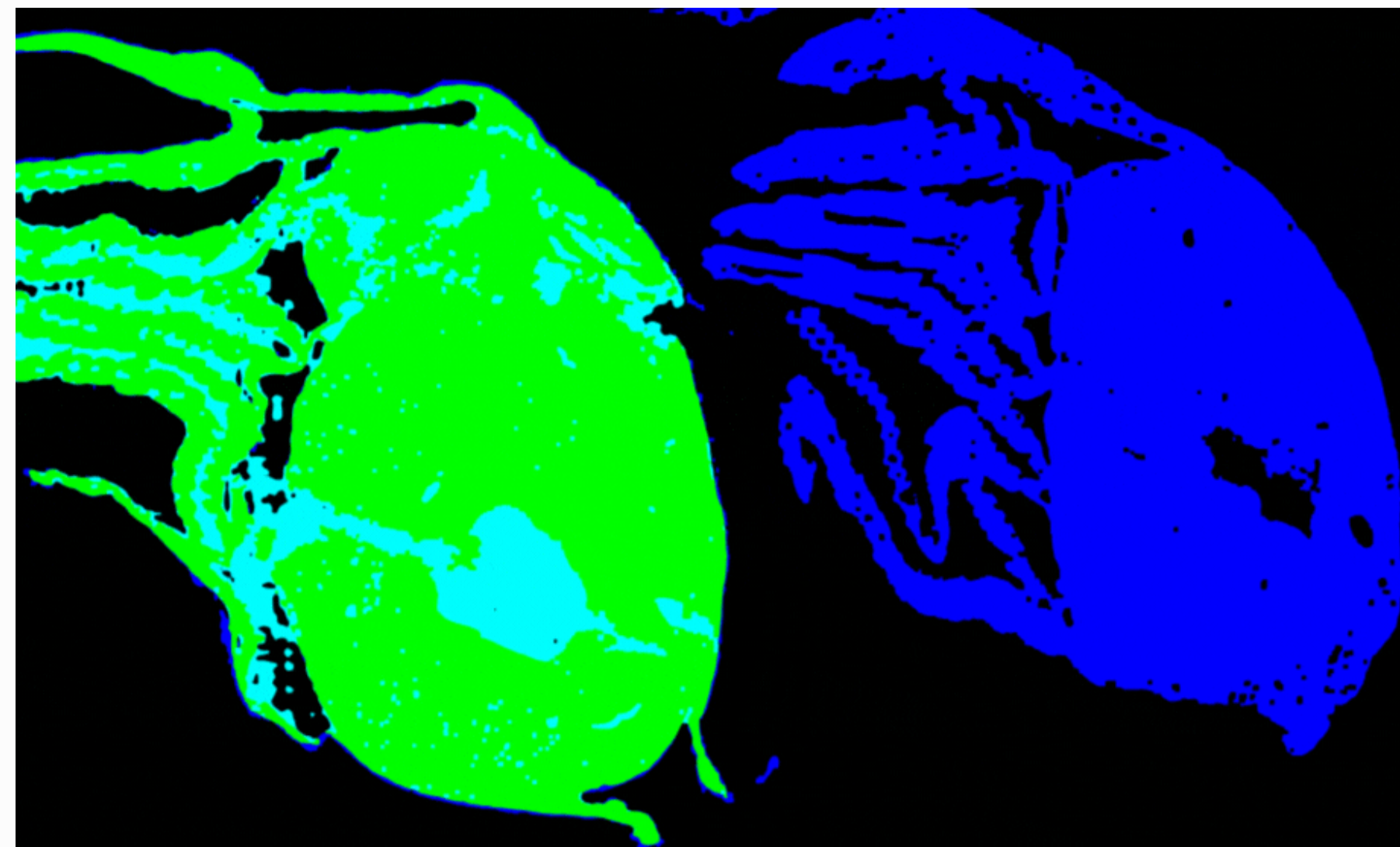
This hybrid strategy uses a simple, reliable method to answer 'where,' and the powerful foundation model to answer 'what.'

- SAM's Guess
- Expert Annotation

Step 1: Generate Robust Prompts (CV)

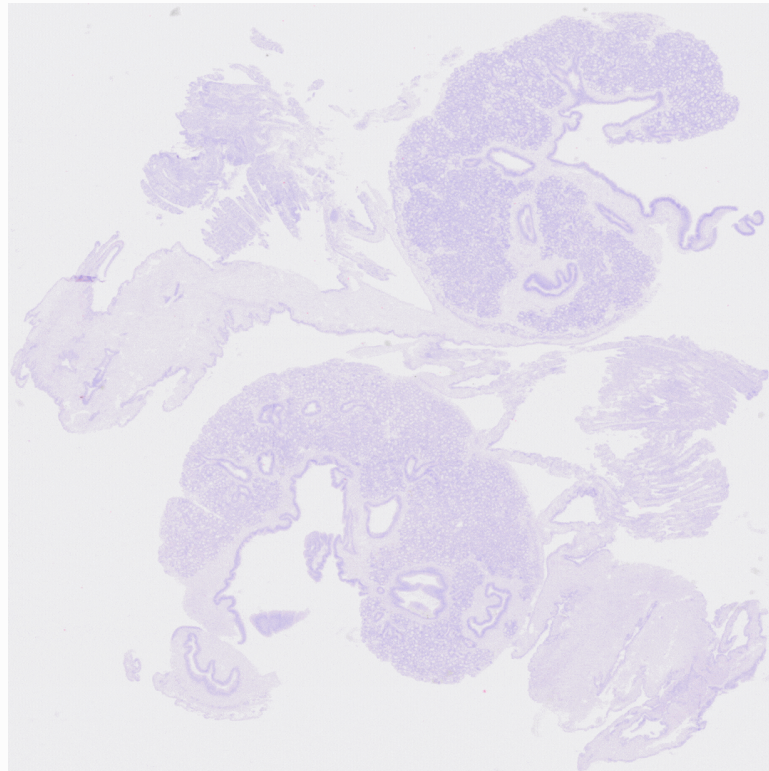


Step 2: Precise Segmentation (SAM)



Current Limitations & Diagnosis

Brittle Prompt
Generation



The current CV - based prompter is the weakest link and can fail on complex slides.

Small Dataset
Size



While 30 slides generate hundreds of thousands of training patches, they don't capture the full range of biological variability needed for a production - ready model.

These limitations are not roadblocks; they are a clear and actionable guide for what to do next.

The Path Forward: A Phased Plan

Medium - Term

Phase 1: Building the Knowledge Base

Objective: Expand the dataset to capture the full range of biological and technical variability.

Action: Utilize the complete HIL pipeline. Use our robust SAM segmenter to pre-annotate 50 - 100+ new slides for rapid expert validation.

Long - Term

Phase 2: Developing the Field - Ready Assistant Tool

Objective: Fulfill the project's primary mission of accelerating MSX diagnosis.

Action: With the segmentation problem solved and a large dataset in place, proceed with training a high-performance YOLO - based MSX detector.

Conclusion & Takeaways

Built the Foundation for a New Tool

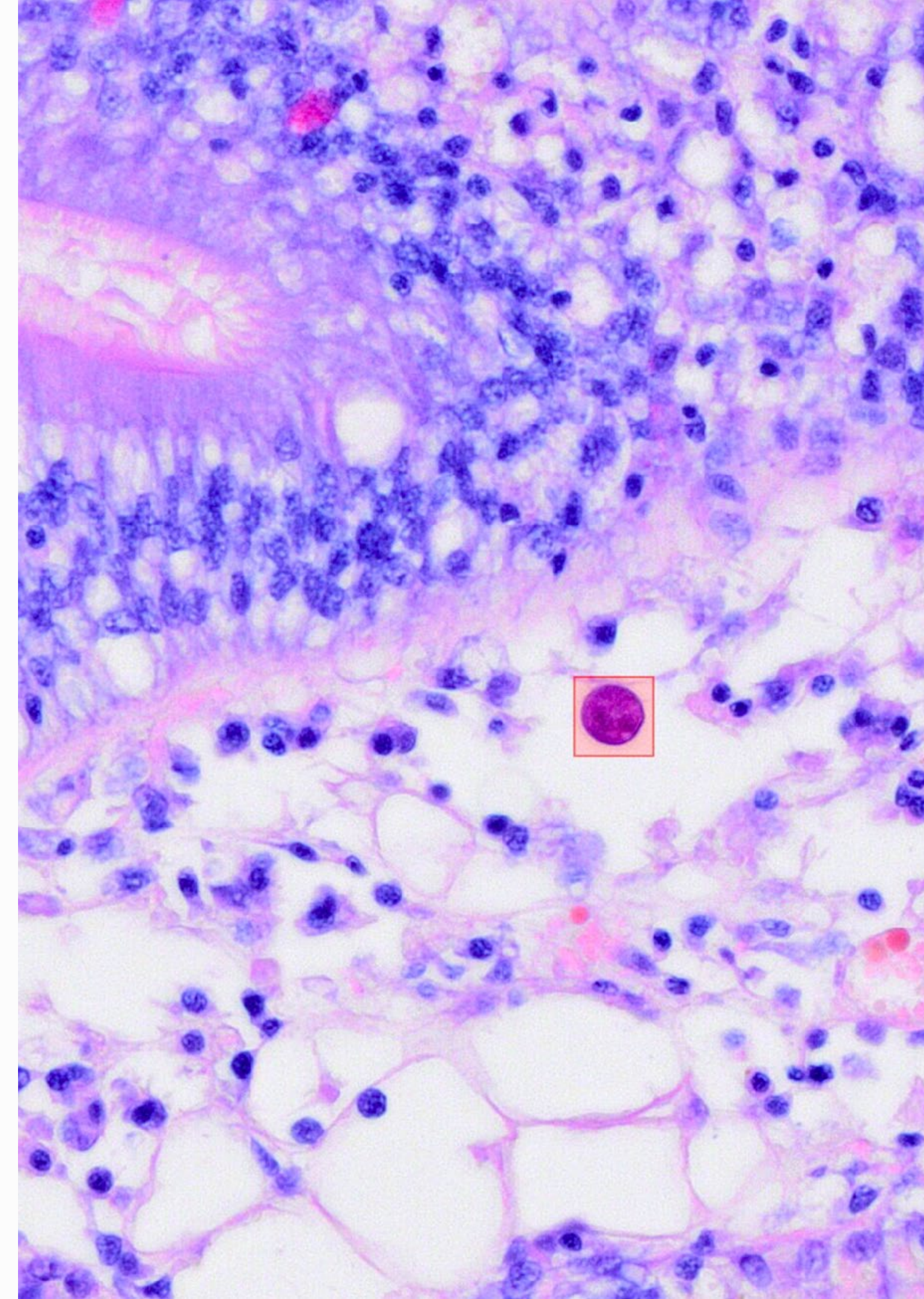
We've successfully engineered a working prototype of an AI - assisted system that is already being used to build our knowledge base.

Achieved High Accuracy on the First Critical Step

We've developed a reliable method to automatically find and separate oysters on a slide, paving the way for parasite detection.

Established a Clear Path to a Field - Ready Solution

We have a concrete, phased plan to turn this successful prototype into a validated tool for pathologists.





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Thank You

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