

Artificial Intelligence in Diagnostic Microscopy

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Light microscope

- Important role in laboratory diagnosis
- Can be done quickly
- Accuracy depends on
 - experience of the technical staff
 - quality of equipment



Microscopic examination in Microbiology

1. Gram stain
2. Acid-fast and modified acid-fast stains
3. Fluorescent stains
4. Wet mounts
5. India ink (colloidal carbon) stain

Microscopic examination in Microbiology

TABLE 1 Resolving power of selected lenses with different NA

Lens system	NA	Light color	Avg wavelength (nm)	Medium	Resolution (μm)
Eye		White	550	Air	700
Hand magnifier	0.03	White	550	Air	10
10 \times objective	0.30	White	550	Air	0.92
40 \times objective	0.75	White	550	Air	0.37
40 \times objective (oil)	1.30	White	550	Oil	0.21
100 \times objective	1.30	White	550	Oil	0.21
100 \times objective	1.30	UV	400	Oil	0.15

Limitation of Light microscopy

- Requires the head and arms to be locked in a forward position
- Inclined to ward the microscope with rounded shoulders
- 70.5% of microscopist reported neck, shoulder, or upper back pain during microscopy
- 56% had an increased prevalence of hand or wrist symptoms

AFB Smear Screening

- Sputum-smear microscopy is the most widely used method for detecting TB
- Sensitivity depends on experience of the technical staff
- Labor intensive
 - 3-5 mins per smear
 - Max 80 smears per day per staff

AI-Based automated AFB Smear Screening System

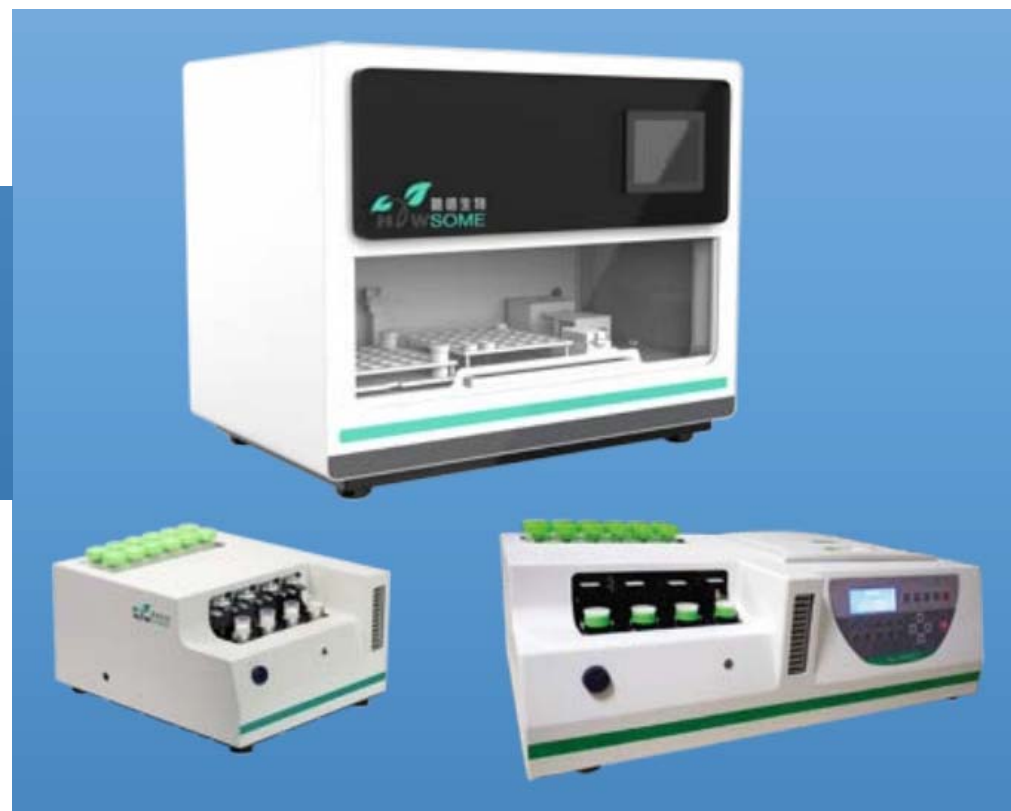


AI-Based automated AFB Smear Screening System

1. Smear preparation machine
2. Automated AFB Stainer
3. Automated AFB Smear Scanner
4. AI-based algorithm / Convolutional neural network (CNN)

Automated smear preparation machine

薄层液基制片原理有效提高检验阳性率
集成震荡·制片·烤片紧凑型一体化设计节省空间
可以置于生物安全柜中进行操作·生物安全好
十三五重大专项推荐产品



Automated AFB smear Stainer



产品多功能：抗酸染色，荧光染色功能互换

占用空间小：仅需要很小的空间就可以安装

染色速度快：抗酸10min，荧光5min

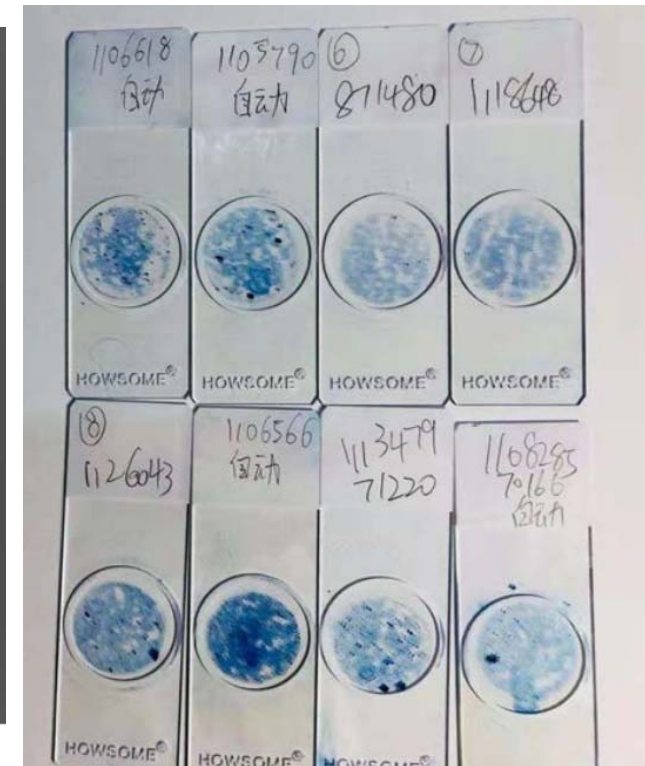
软件使用易：无需培训，直接上手

试剂安全可靠：碱性复红全进口试剂，没有黑色沉渣

临床覆盖广：直涂，消化等不同样本

无附加耗材：染色成本低，没有附加耗材

可以升级Android版本：客户可以增加平板版本



Automated AFB Smear Scanner



产品多功能：更换模块就可以完成产品升级

占用空间小：单片，5片，50，100

扫描速度快：明场2min/t，荧光1min/t

软件使用易：无需培训，直接上手

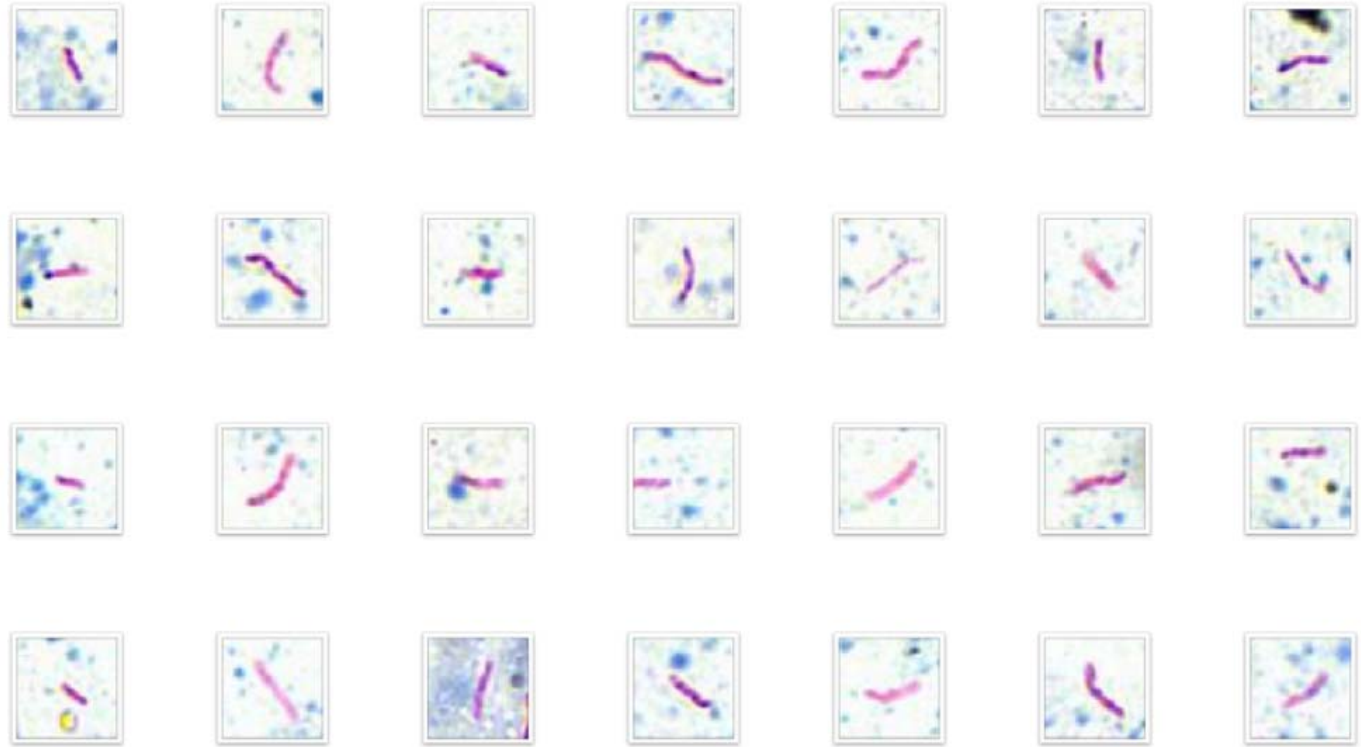
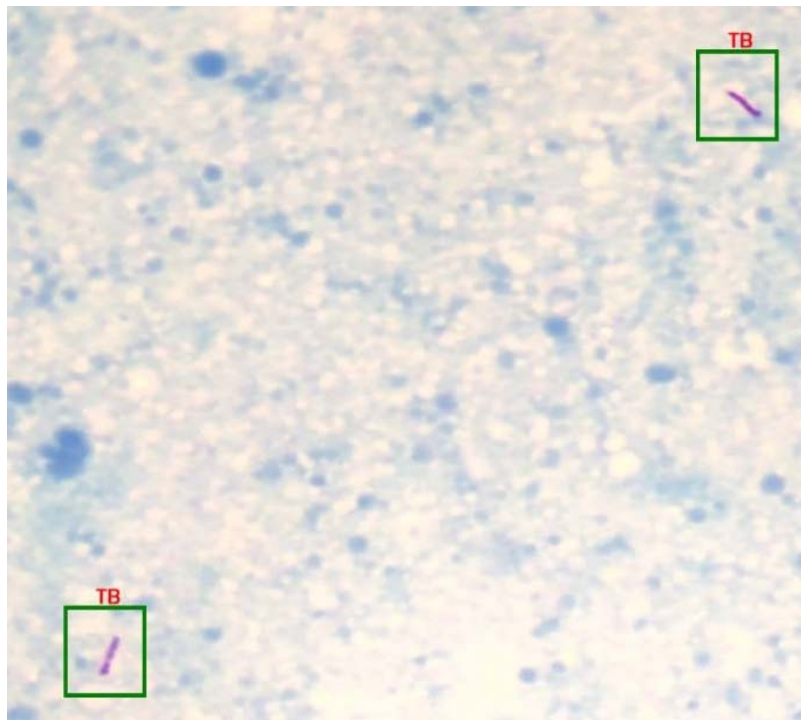
远程维护快：程序升级方便，

数据统计爽：图文化数据，数据也可导出

流行病统计：加上云模块可以实现实时数据收集

神经网络算法：采用神经网络的算法，可以根据

Automated AFB Smear Scanner

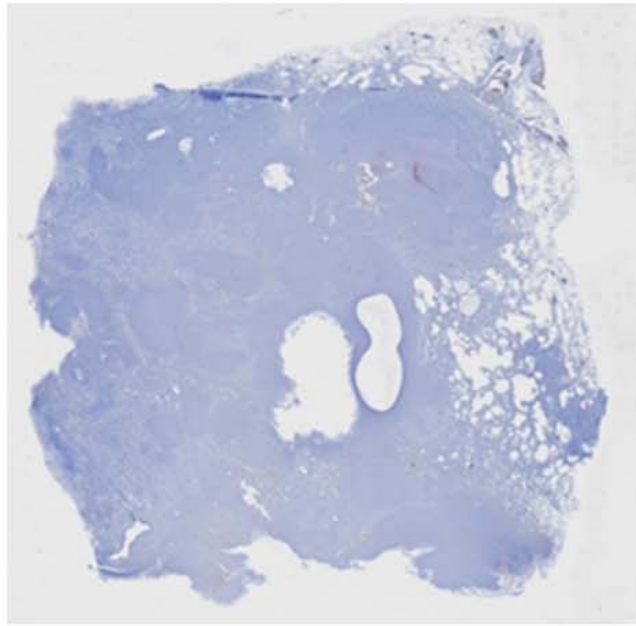


Convolutional neural network (CNN)

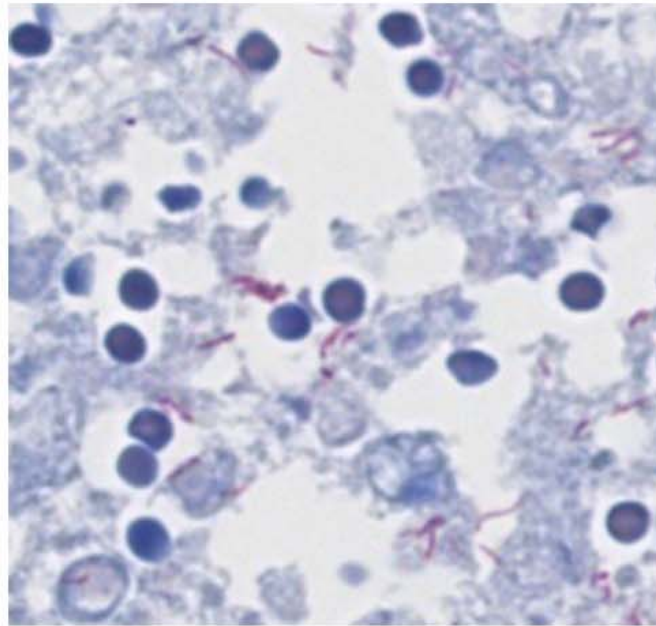
- Deep learning model
- Particularly designed for learning of two-dimensional data such as images
- Hierarchical structure of learning layers
- Improve the accuracy of the feedforward-backpropagation training procedure
- Model very complex features
- Provide a general-purpose learning framework not requiring beforehand feature extraction and fine-tuning

Overview of the CNN models

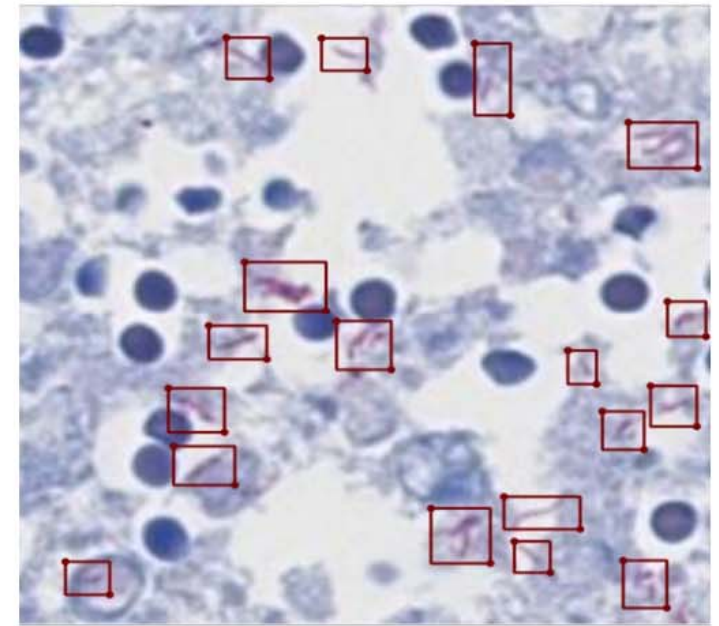
Model	Depth	Input Size
ResNet50	50 layers (Convolutional + Fully Connected)	224 × 224
Inception v3	48 layers (Inception modules + Fully Connected)	299 × 299
Xception	71 layers (Convolutional + Separable Convolutions)	299 × 299
DenseNet169	169 layers (Convolutional + Pooling + Batch Normalization)	224 × 224
EfficientNet-B0	Varied due to compound scaling method	224 × 224
RegNetY-064	64 stages (Sequence of Convolutional layers)	224 × 224
NASNet-A Large	280 layers (Convolutional)	332 × 332
Vit_base_patch16_224	12 Transformer layers	224 × 224
Swin Transformer Small	110 layers (due to hierarchical structure)	224 × 224



(a)



(b)



(c)

Figure 1. Examples of annotations. (a) Whole slide image of lung tissue containing *Mycobacterium tuberculosis*; Ziehl–Neelsen staining, scanning magnification view; (b) cropped patch image of (a), 400×; (c) annotated short, rod-shaped bacilli.

Diagnostic performance

Table 4. Diagnostic Performance of MTSS and CM for Detection of TB Compared to Culture Methods

	Sites	Sensitivity (%)	Specificity (%)	PPV (%)	NPV (%)
AI Microscopy	Correct No./Total No. (%)	903/1,144 (78.9)	2,496/2,657 (93.9)	903/1,064 (84.9)	2,496/2,737 (91.2)
	95% CI	76.6-81.3	93.0-94.8	82.7-87.0	90.1-92.3
Conventional Microscopy	Correct No./Total No. (%)	886/1,144 (77.4)	2,523/2,657 (95.0)	886/1,020 (86.9)	2,523/2,781 (90.7)
	95% CI	75.0-79.9	94.1-95.8	84.8-88.9	89.6-91.8

Diagnostic performance

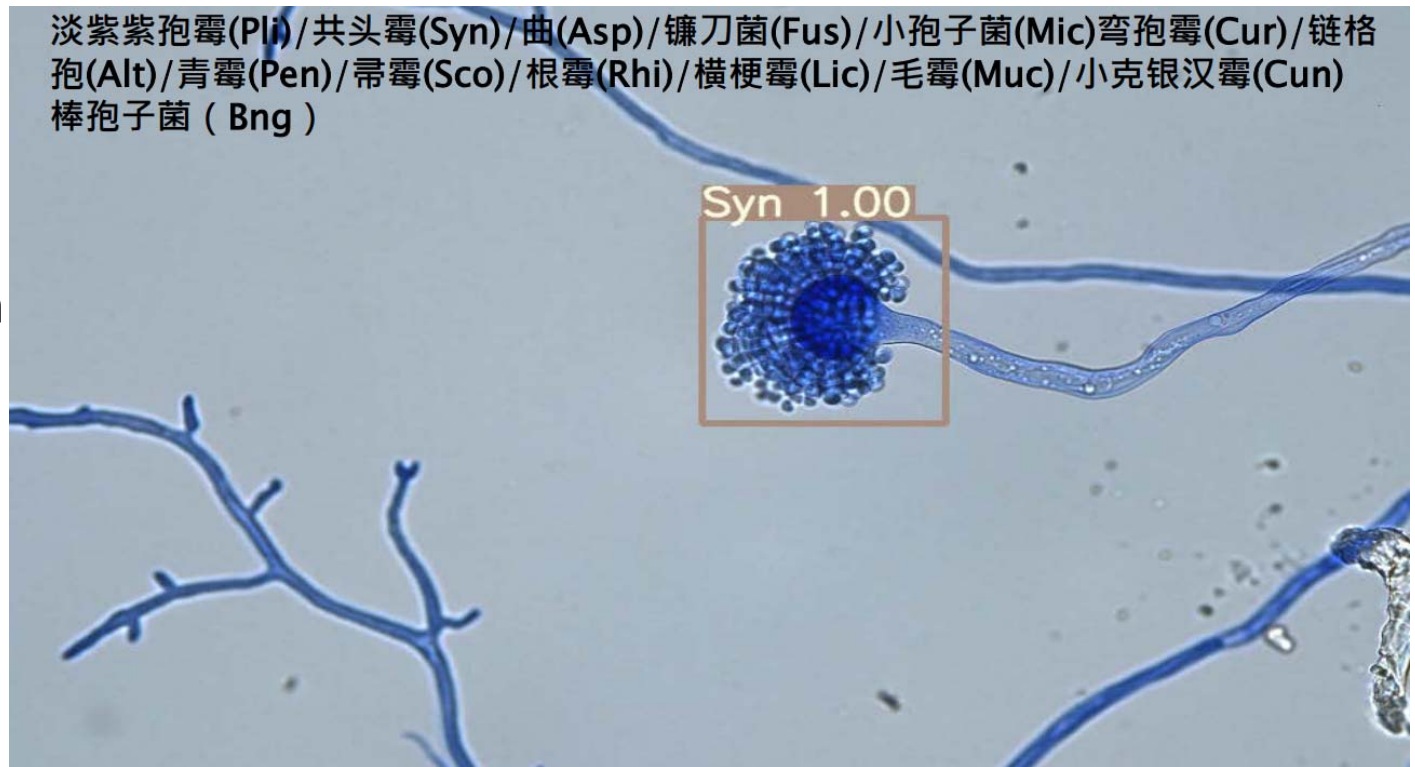
- Positive rate of AFB smear increased for 10%
- Compared with culture method
 - Sensitivity > 80%
 - Specificity > 95%

专家意见表

项目名称	皓信抗酸杆菌自动染色和数字扫描系统多中心评估项目		
项目研究单位	中国防痨协会 中国疾控中心国家结核病参比实验室	项目负责人	赵雁林
<p>2015年11月-2016年12月,受上海皓信生物科技有限公司委托,中国防痨协会对该公司研制的自动染色和数字扫描系统(MTSS)进行了多中心现场应用评估。经专家组对评估结果讨论一致认为:MTSS系统与传统染色镜检方法相比,自动化程度和检测阳性率高,系统性能稳定,适合在各级医疗卫生机构结核病筛查和诊断中的推广应用。</p> <p>主要特点:</p> <ol style="list-style-type: none">1. MTSS系统染色镜检自动化,操作简单,能有效减轻实验人员工作量。2. MTSS系统与传统染色镜检方法相比,阳性检出率提高10%;与培养结果相比,灵敏度约80%,特异度达到95%以上。3. MTSS系统检测结果更为客观,不受人为因素影响。4. MTSS系统具有互联网拓展功能,可实现结果远程共享,易开展质量控制。 <p>建议:</p> <p>进一步整合自动制片系统,实现涂片染色镜检一体化;研发适合各级各类医疗机构使用的不同通量的自动化系统。</p>			

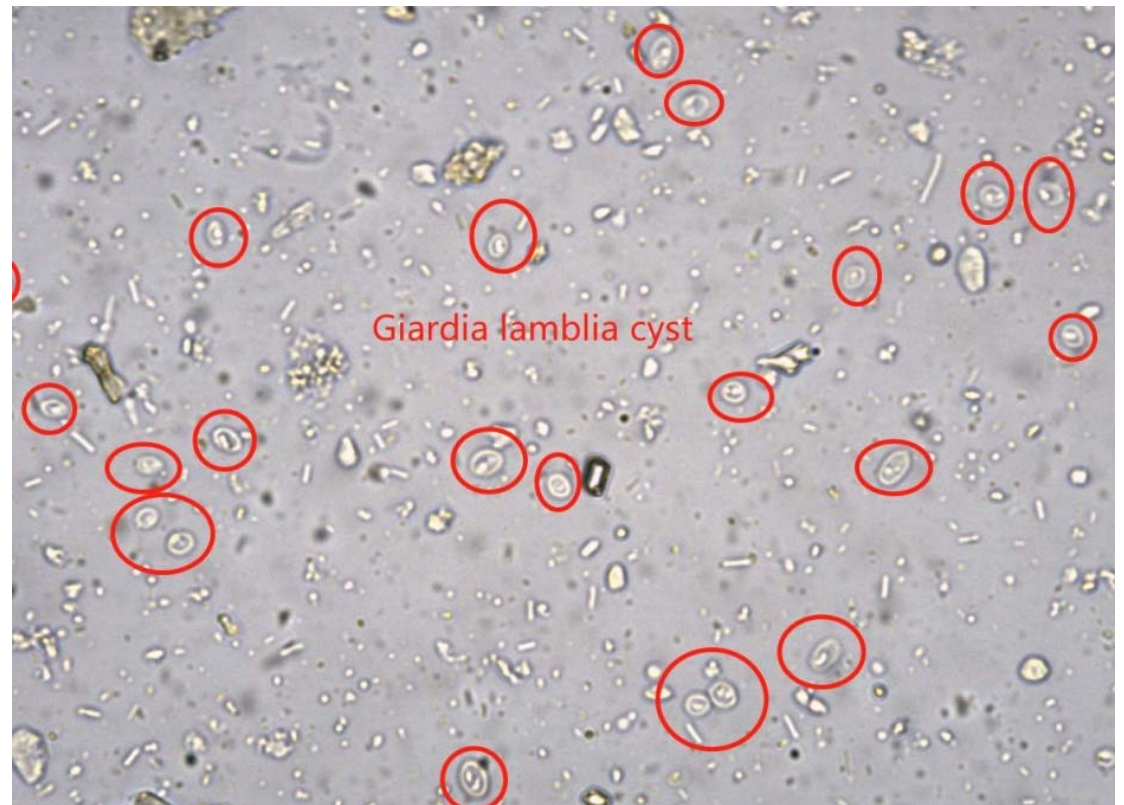
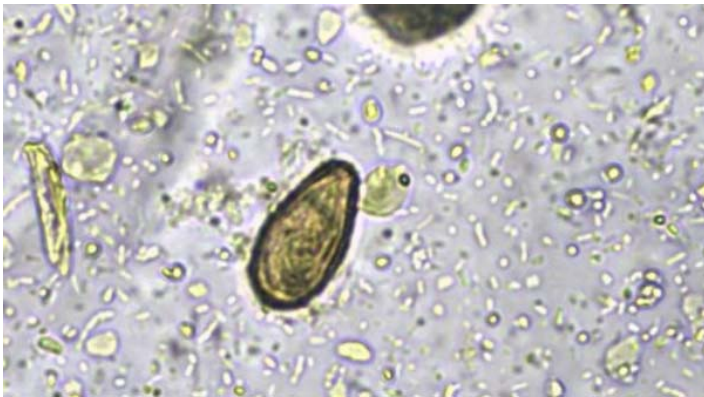
Application of AI Microscopy in Microbiology

- AFB smear screening
- **Fungus identification**
- Parasite identification
- Agar plate examination



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