Wisconsin State Laboratory of Hygiene

UNIVERSITY OF WISCONSIN–MADISON

Laboratory 101

Nate Simon
TB Laboratory Program Coordinator
Wisconsin State Laboratory of Hygiene

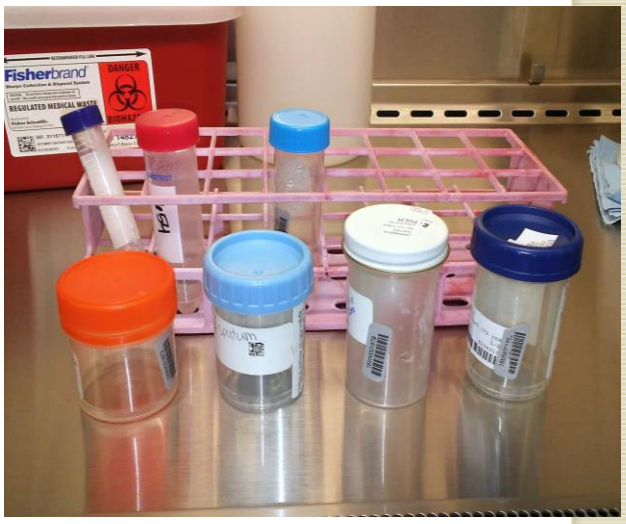
Objectives

- Specimen collection
- Specimen storage and transport
- Testing offered at WSLH
- Result reporting and interpretation
- Expected turn around times for results

Specimen Types

Almost any source is acceptable for AFB culture and smear

- **Sputum**
  - **Induced**
  - **Expectorated**
- Bronchial washing/BAL
- Gastric aspirate
- Fresh tissue
- Bone
- Blood
- Bone Marrow
- CSF
- Body fluids
- Abscess
- Stool
- Urine
- Skin



Sputum

- Recently discharged material from the bronchial tree, with minimal amounts of oral or nasal material
  - Expectorated: from deep productive cough
  - Induced: use of nebulization to increase fluid in the airway and ease clearance of sputum

Purposes of sputum collection:

- To establish an initial diagnosis of TB
- To monitor the infectiousness of the patient
- To determine the effectiveness of treatment

Image Credit: WHO

Specimen collection

- Supervise patient for at least the first specimen, until ability to properly collect the specimen has been demonstrated
- Patient should be in a negative pressure room
- Anyone in the room should wear a fit tested N-95 respirator
- All specimens are collected into sealed leak proof containers
- Label specimen with two patient identifiers, collection date/time and specimen type.

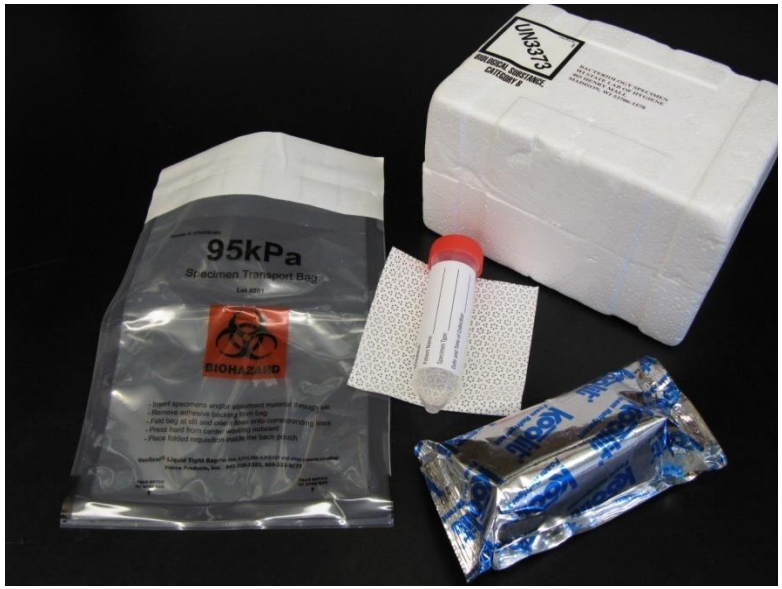
Specimen collection

- Optimal: collect a diagnostic specimen before the initiation of drug therapy
  - Collect a series of three sputum specimens, 8-24 hours apart, at least one of which is an early morning specimen
- Monitoring of therapy: Obtain sputum specimens for culture at least monthly until cultures convert to negative for TB

Specimen collection kits

WSLH Kit #8: Sputum collection
Order: 1-800-862-1088

KITS ARE FREE!



- Sterile tube with label
- Absorbent pad
- Specimen transport bag
- Cold pack
- Instruction sheet
- Insulated mailer with labels

Storage and Transport

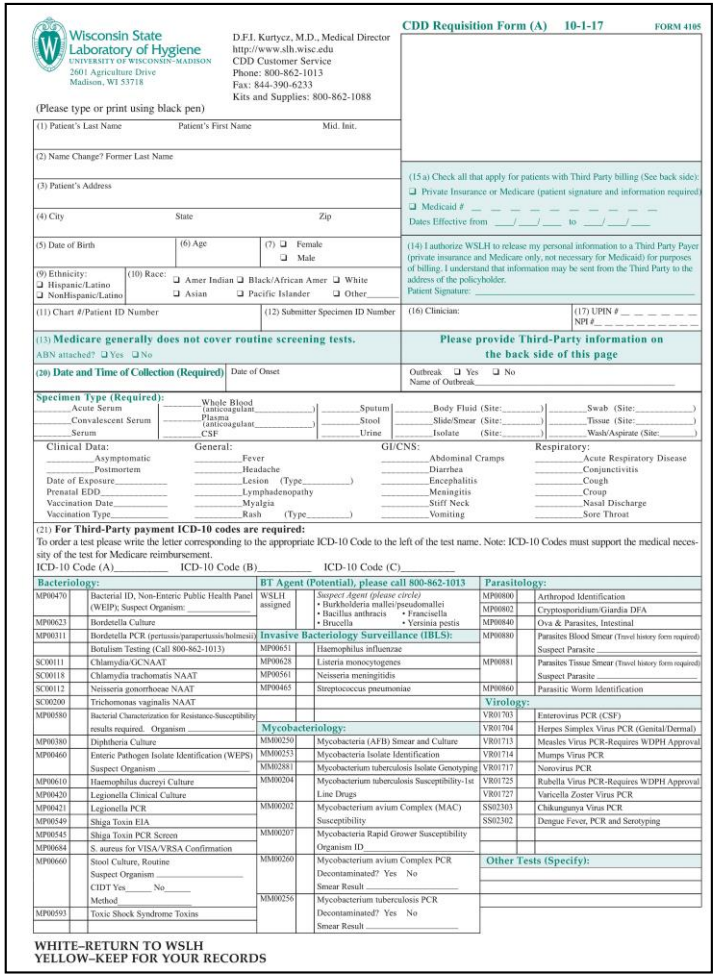
- Sputum samples should be refrigerated if they cannot be transported immediately
- Deliver specimens to the laboratory as soon as possible—try not to batch!
- Recommended: Include a cold pack during specimen transport.

Storage and Transport

Why is this important?

- Minimize overgrowth of normal flora
- Viability of AFB
- Rapid turn-around times
  - Isolation precautions
  - Start/Stop treatment

Submission of Specimens to WSLH



Wisconsin State Laboratory of Hygiene
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D.F.I. Kurtycz, M.D., Medical Director
http://www.slh.wisc.edu
CDD Customer Service
Phone: 800-862-1013
Fax: 844-390-6233
Kits and Supplies: 800-862-1088

CDD Requisition Form (A) 10-1-17 FORM 4105

(Please type or print using black pen)

(1) Patient's Last Name | Patient's First Name | Mid. Init.

(2) Name Change? Former Last Name

(3) Patient's Address

(4) City | State | Zip

(5) Date of Birth | (6) Age | (7) ❑ Female ❑ Male

(9) Ethnicity: ❑ Hispanic/Latino ❑ NonHispanic/Latino
(10) Race: ❑ Amer Indian ❑ Black/African Amer ❑ White ❑ Asian ❑ Pacific Islander ❑ Other

(11) Chart #/Patient ID Number | (12) Submitter Specimen ID Number

(15a) Check all that apply for patients with Third Party billing (See back side):
❑ Private Insurance or Medicare (patient signature and information required)
❑ Medicaid # — — — — — — — — — —
Dates Effective from ___/___/___ to ___/___/___

(14) I authorize WSLH to release my personal information to a Third Party Payer (private insurance and Medicare only, not necessary for Medicaid) for purposes of billing. I understand that information may be sent from the Third Party to the address of the policyholder.
Patient Signature: _____

(16) Clinician: | (17) UPIN # — — — — — —
NPI # — — — — — — — — — —

(13) **Medicare generally does not cover routine screening tests.**
ABN attached? ❑ Yes ❑ No

Please provide Third-Party information on the back side of this page

(20) **Date and Time of Collection (Required)** | Date of Onset

Outbreak ❑ Yes ❑ No
Name of Outbreak _____

Specimen Type (Required):

_____Acute Serum	_____Whole Blood (anticoagulant_____)	_____Sputum	_____Body Fluid (Site:_____)	_____Swab (Site:_____)
_____Convalescent Serum	_____Plasma (anticoagulant_____)	_____Stool	_____Slide/Smear (Site:_____)	_____Tissue (Site:_____)
_____Serum	_____CSF	_____Urine	_____Isolate (Site:_____)	_____Wash/Aspirate (Site:_____)

Clinical Data:	General:	GI/CNS:	Respiratory:
_____Asymptomatic	_____Fever	_____Abdominal Cramps	_____Acute Respiratory Disease
_____Postmortem	_____Headache	_____Diarrhea	_____Conjunctivitis
Date of Exposure_____	_____Lesion (Type_____)	_____Encephalitis	_____Cough
Prenatal EDD_____	_____Lymphadenopathy	_____Meningitis	_____Croup
Vaccination Date_____	_____Myalgia	_____Stiff Neck	_____Nasal Discharge
Vaccination Type_____	_____Rash (Type_____)	_____Vomiting	_____Sore Throat

(21) **For Third-Party payment ICD-10 codes are required:**
To order a test please write the letter corresponding to the appropriate ICD-10 Code to the left of the test name. Note: ICD-10 Codes must support the medical necessity of the test for Medicare reimbursement.
ICD-10 Code (A)_____ ICD-10 Code (B)_____ ICD-10 Code (C)_____

Bacteriology:

MP00470	Bacterial ID, Non-Enteric Public Health Panel (WEIP); Suspect Organism: _____	WSLH assigned
MP00623	Bordetella Culture	
MP00311	Bordetella PCR (pertussis/parapertussis/holmesii)	
	Botulism Testing (Call 800-862-1013)	
SC00111	Chlamydia/GCNAAT	
SC00118	Chlamydia trachomatis NAAT	
SC00112	Neisseria gonorrhoeae NAAT	
SC00200	Trichomonas vaginalis NAAT	
MP00580	Bacterial Characterization for Resistance-Susceptibility results required. Organism _____	
MP00380	Diphtheria Culture	
MP00460	Enteric Pathogen Isolate Identification (WEPS) Suspect Organism _____	
MP00610	Haemophilus ducreyi Culture	
MP00420	Legionella Clinical Culture	
MP00421	Legionella PCR	
MP00549	Shiga Toxin EIA	
MP00545	Shiga Toxin PCR Screen	
MP00684	S. aureus for VISA/VRSA Confirmation	
MP00660	Stool Culture, Routine Suspect Organism _____ CIDT Yes_____ No_____ Method _____	
MP00593	Toxic Shock Syndrome Toxins	

BT Agent (Potential), please call 800-862-1013

Suspect Agent (please circle)
• Burkholderia mallei/pseudomallei • Bacillus anthracis • Francisella • Brucella • Yersinia pestis

Invasive Bacteriology Surveillance (IBLS):

MP00651	Haemophilus influenzae
MP00628	Listeria monocytogenes
MP00561	Neisseria meningitidis
MP00465	Streptococcus pneumoniae

Mycobacteriology:

MM00250	Mycobacteria (AFB) Smear and Culture
MM00253	Mycobacteria Isolate Identification
MM02881	Mycobacterium tuberculosis Isolate Genotyping
MM00204	Mycobacterium tuberculosis Susceptibility-1st Line Drugs
MM00202	Mycobacterium avium Complex (MAC) Susceptibility
MM00207	Mycobacteria Rapid Grower Susceptibility Organism ID _____
MM00260	Mycobacterium avium Complex PCR Decontaminated? Yes No Smear Result _____
MM00256	Mycobacterium tuberculosis PCR Decontaminated? Yes No Smear Result _____

Parasitology:

MP00800	Arthropod Identification
MP00802	Cryptosporidium/Giardia DFA
MP00840	Ova & Parasites, Intestinal
MP00880	Parasites Blood Smear (Travel history form required) Suspect Parasite _____
MP00881	Parasites Tissue Smear (Travel history form required) Suspect Parasite _____
MP00860	Parasitic Worm Identification

Virology:

VR01703	Enterovirus PCR (CSF)
VR01704	Herpes Simplex Virus PCR (Genital/Dermal)
VR01713	Measles Virus PCR-Requires WDPH Approval
VR01714	Mumps Virus PCR
VR01717	Norovirus PCR
VR01725	Rubella Virus PCR-Requires WDPH Approval
VR01727	Varicella Zoster Virus PCR
SS02303	Chikungunya Virus PCR
SS02302	Dengue Fever, PCR and Serotyping

Other Tests (Specify):

WHITE–RETURN TO WSLH
YELLOW–KEEP FOR YOUR RECORDS

- Requisition form A
- Order: 1-800-862-1088
- Preprinted with account information
- One form per specimen

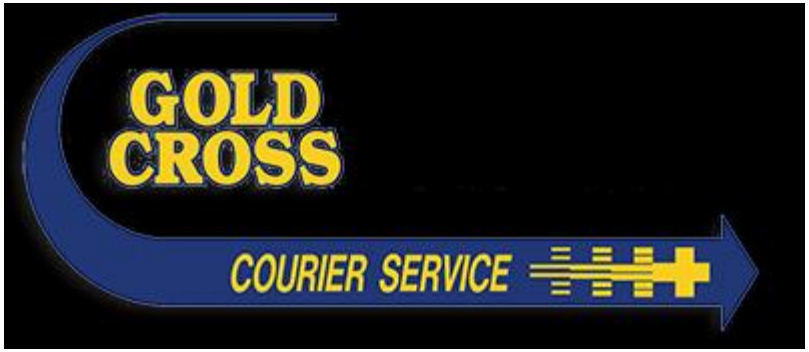
Submission of Specimens to WSLH

Code		Test Description
MM00250	✖	Mycobacteria (AFB) Smear and Culture
MM00253		Mycobacteria Isolate Identification
MM02881		Mycobacterium tuberculosis Isolate Genotyping
MM00204		Mycobacterium tuberculosis Susceptibility-1st Line Drugs
MM00202		Mycobacterium avium Complex (MAC) Susceptibility
MM00260		Mycobacterium avium Complex PCR Decontaminated? Yes No Smear Result _____
MM00256		Mycobacterium tuberculosis PCR Decontaminated? Yes No Smear Result_____

Courier information

Service is offered at no charge to submitters

Call to set up an account and schedule a pickup:
763-233-0099



Assessing Sputum Quality

Test results are used as an aid in patient diagnosis and treatment.

Test results are directly related to the quality of the specimen.

Assessing Specimen Quality

Collection Date/Time:

- CDC MMWR 2005: 54, RR-17: "Persons requiring sputum collection for smear and culture should have at least three consecutive sputum specimens obtained, each collected in 8-24 hour intervals, with at least one being an early morning specimen"
- Specimens >7 days old will be rejected

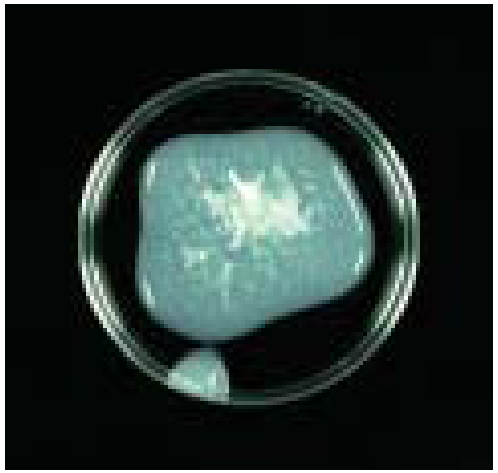
Assessing Specimen Quality

Sputum Quality

- Specimens are thick and contain mucopurulent material
- 3-5 ml in volume, but smaller quantities accepted if the quality is satisfactory
  - <1 ml sputum will be rejected
- Poor quality specimens are thin and watery—Saliva and nasal secretions are unacceptable
- Induced sputum should be indicated on requisition form to avoid rejection

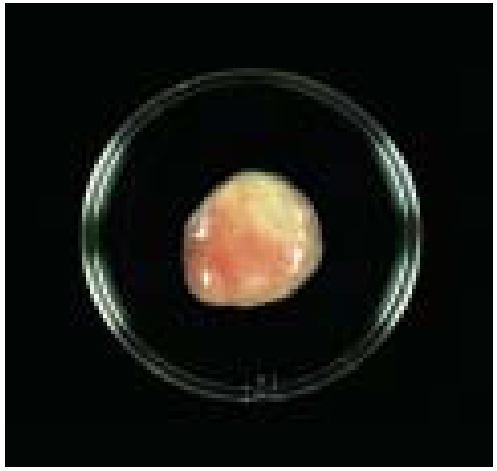
Assessing Specimen Quality

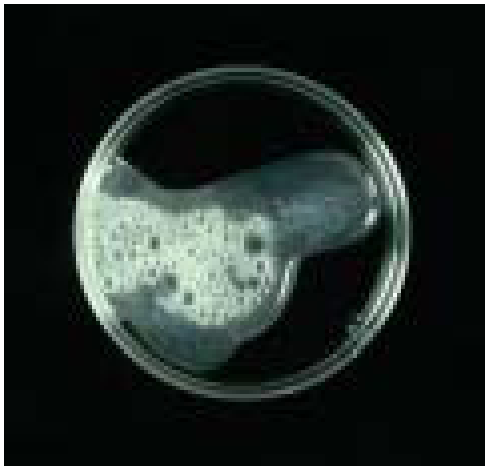
Thick Mucopurulent



Watery (induced?)

Hemoptysis





Salivary

http://www.theunion.org

Mycobacteriology at WSLH

- Full-service mycobacteriology laboratory
- BSL-3 facility
- Roles:
  - Primary Diagnostic Facility
  - Reference laboratory
  - Public Health Laboratory

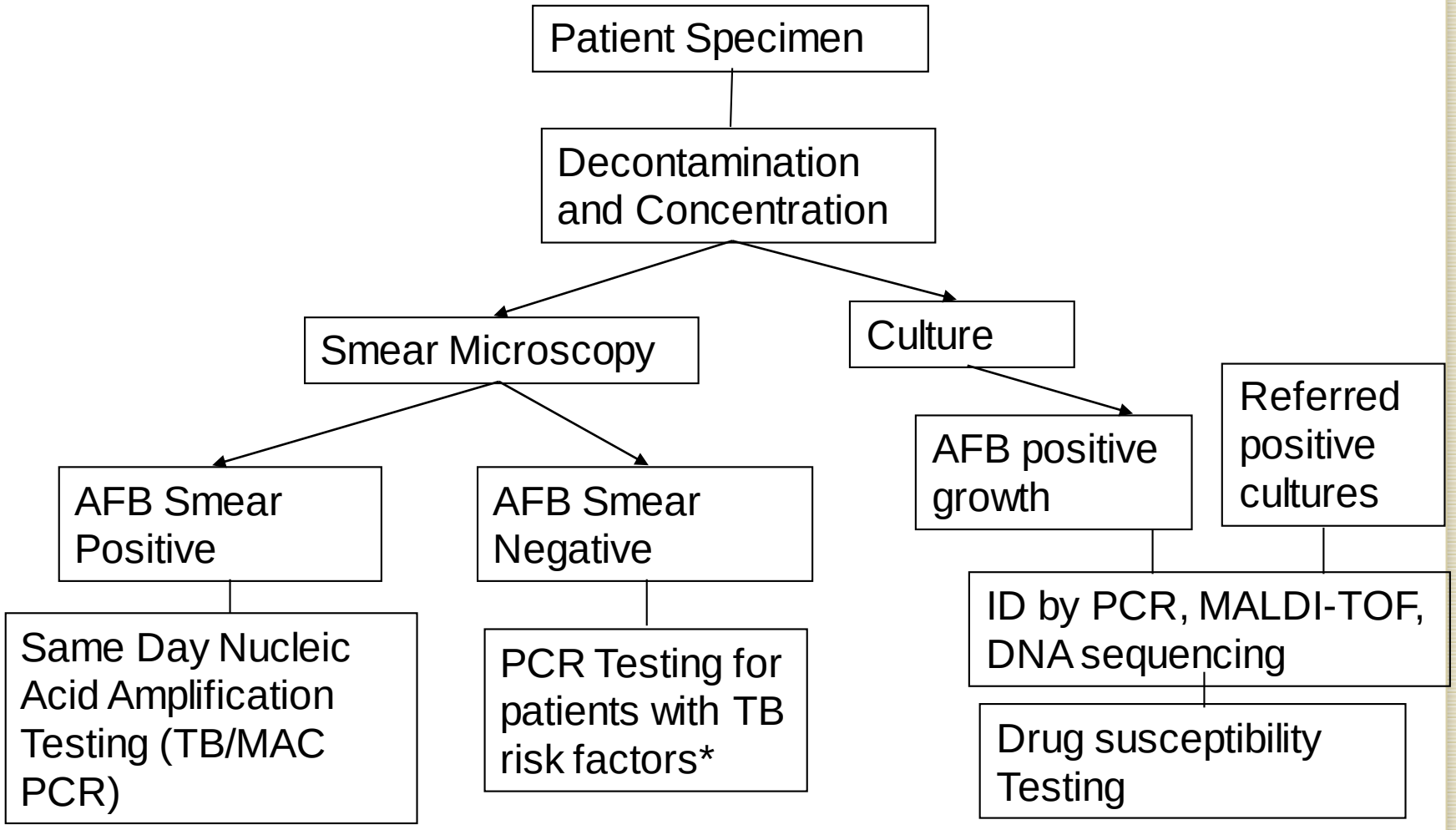
Mycobacteriology at WSLH

- 22 laboratories around the state perform smear and culture
  - 5 labs perform some level of identification
  - Most others send to WSLH for identification
- WSLH receives clinical specimens from:
  - 2 large local hospitals
  - Health Departments (state-wide)
    - Milwaukee City TB Clinic
    - Madison Dane County Public Health

Mycobacteriology at WSLH

- Smear Microscopy
- PCR for direct detection
- Culture
- Identification
- Drug Susceptibility Testing
  - Molecular
  - Conventional

Mycobacteriology Testing at WSLH



Smear Microscopy

- Small amount of concentrated patient specimen is placed on slide and stained with Auramine O fluorescent stain
- Rapid and inexpensive screening tool
  - First indication of mycobacterial infection and possible TB disease
  - Must be accompanied by additional testing including culture for confirmatory diagnosis

Auramine O Smear

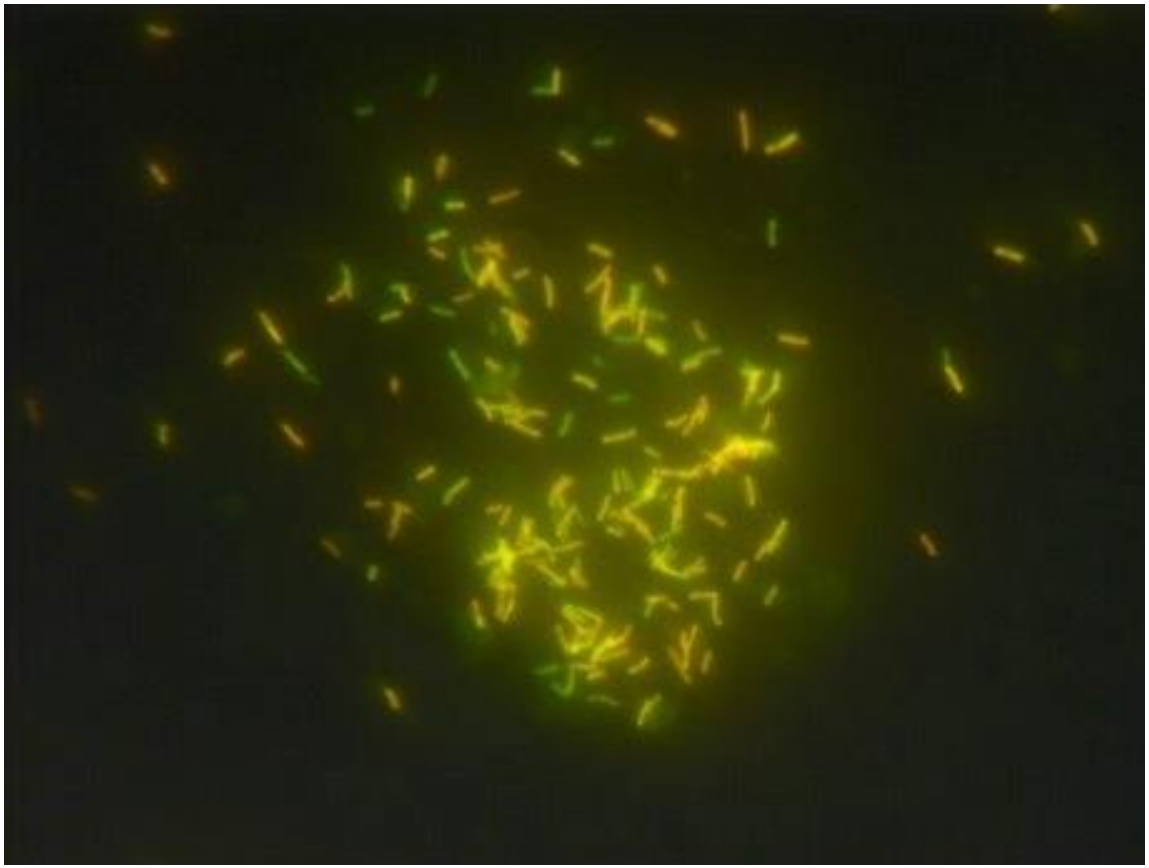


Photo Credit: laboratoryinfo.com

Smear Microscopy: Result Interpretation

WSLH Report	Graded Scale	Qualitative Scale	Interpretation
Negative	Negative	Negative	Potentially infectious
Rare (1-9 AFB per 100 fields)	1+	Positive	Low-level infectious
Few (1-9 AFB per 10 fields)	2+	Positive	Moderately infectious
Moderate (1-9 AFB per field)	3+	Positive	
Many (>9 AFB per field)	4+	Positive	Highly infectious

Microscopy Results Guide Decisions

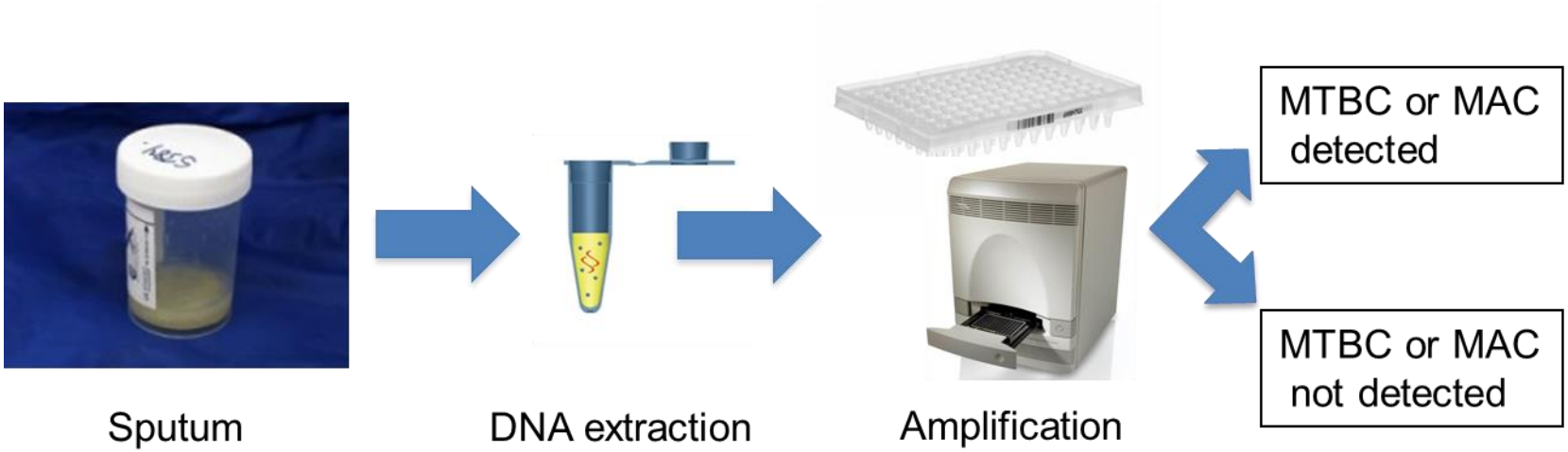
- Clinical Management
  - Patient therapy may be initiated for TB
  - Changes in smear status important to monitor response to therapy
- Public health interventions
  - Smear status and grade useful for identifying the most infectious cases
  - Contact investigation priority based on smear result
  - Decisions regarding respiratory isolation

Smear Microscopy: Limitations

- Does not distinguish between viable and dead organisms
- Limited sensitivity
  - High bacterial load: 5,000-10,000 AFB/mL is required for detection
  - Misses >45% of U.S. TB cases
- Limited specificity
  - All mycobacteria are acid fast
  - Does not provide species identification
- Cannot be done without a culture

Direct Detection using PCR

- AKA: Nucleic Acid Amplification Testing (NAAT)



WSLH PCR testing

- Detect *M. tuberculosis* complex (MTBC) and *M. avium* complex (MAC) directly from sputum (or other specimen) sediment
- PCR test developed at WSLH
  - 1 other laboratory in the state is performing NAAT (Cepheid GeneXpert)
- Testing takes about 2 hours
- Unable to distinguish live and dead bacilli

PCR testing (cont.)

- Automatically performed on new smear positive patients
- Fee-exempt testing for smear positive specimens and patients suspected of having active TB (approved by WI TB Program)
- Sensitivity
  - >95% for AFB smear-positive, culture-confirmed TB patients
  - 55-75% of AFB smear-negative, culture-confirmed TB patients

TB/MAC PCR Specimen Types

Test	Specimen Type	Smear Result
TB PCR	Respiratory	Smear positive and smear negative*
TB PCR	Non-respiratory	Smear positive only
MAC PCR	Respiratory and non-respiratory	Smear positive only

*Smear-negative TB PCR requires approval from the TB program for fee-exempt testing. Submitters may choose to pay for TB PCR testing on smear-negative respiratory specimens.

Who should be tested?

- CDC recommendation: First sputum of all patients suspected to have TB for whom the test result would alter case management or TB control activities
  - Should not be routinely ordered when clinical suspicion of TB is low.
- PCR testing is diagnostic only! Not to be used in place of smear to remove patients from isolation!

Updated Guidelines for the Use of Nucleic Acid Amplification Tests in the Diagnosis of Tuberculosis MMWR 2009; 58 (01); 7-10

Wisconsin TB PCR Criteria (Fee-exempt testing)

- Patient must have signs and symptoms of pulmonary TB
- Patient must be reported to the local or state public health department as a suspect TB case as required by Wisconsin Statute Chapter 252.05 and Wisconsin Administrative Code Chapter HFS 145.04 (3)(a).
- Patient must be in respiratory isolation

Wisconsin TB PCR Criteria (Cont.)

- Patient must not have been diagnosed with TB or a non-tuberculous mycobacterial infection within the last 12 months

- Patient must have received ≤7 days of anti-mycobacterial therapy or no such treatment within the last 12 months

Interpretation of PCR Results

WSLH Lab Report	Interpretation
"*Mycobacterium tuberculosis* complex DNA detected"	Positive for TB
"*Mycobacterium avium* complex DNA detected"	Positive for MAC
"No *Mycobacterium tuberculosis* complex DNA detected"	Negative for TB
"No *Mycobacterium avium* complex DNA detected"	Negative for MAC
"Inhibitory substances that prevent nucleic acid amplification were detected"	Test is of no diagnostic help

Advantages of PCR Testing

- More rapid diagnosis
- Diagnosis in smear negative patients
- Initiation of earlier treatment
- Cost savings for patient isolation
- Faster reporting to TB programs
- Fewer transmissions

TB/MAC PCR Goals

Identify smear-positive TB patients within 48 hours (Target: 77%)

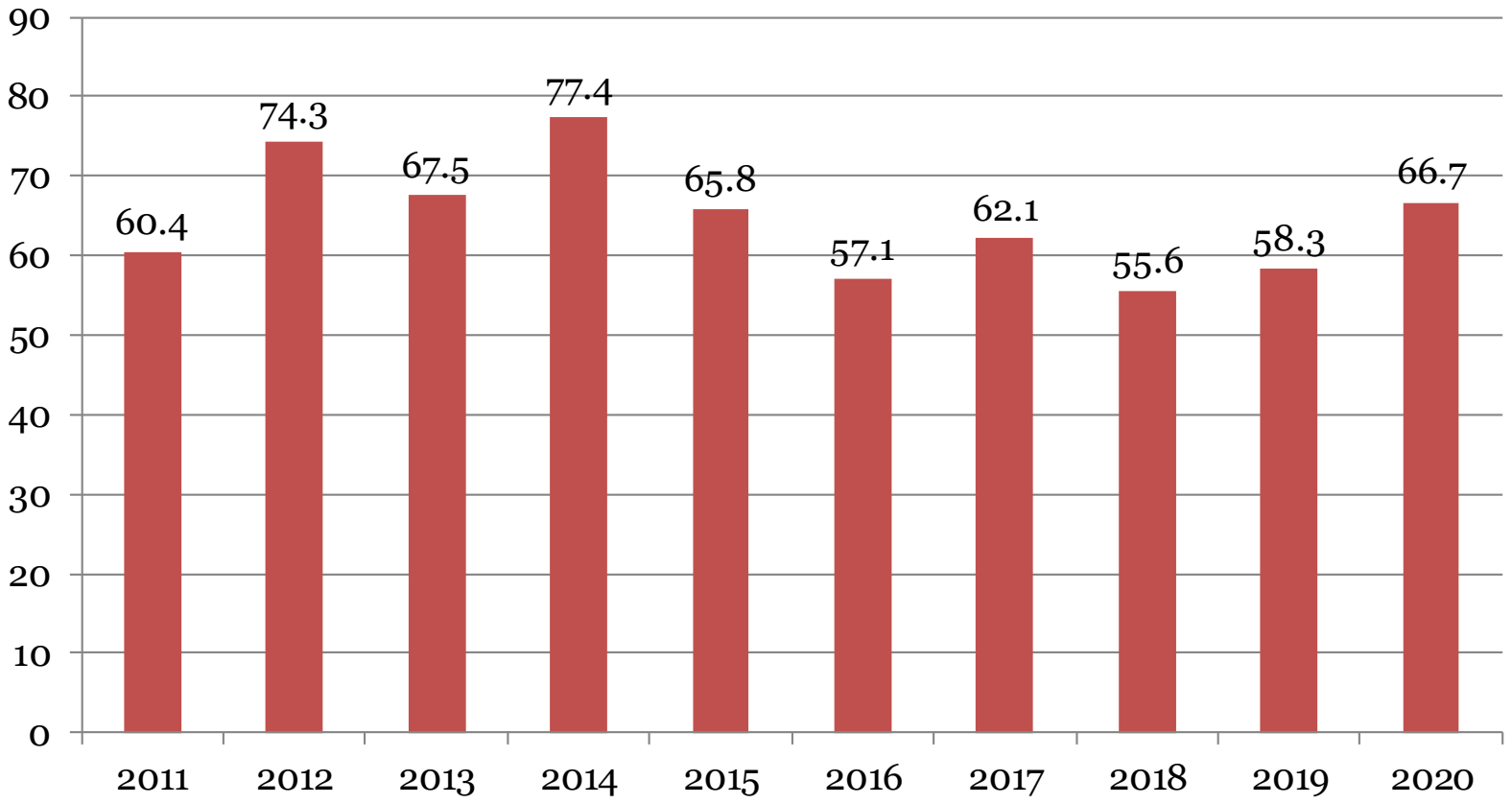
- Respiratory isolation
- Start therapy

Identify smear positive MAC patients

- Release from isolation
- Alter therapy decisions

Presumptive rapid results for about 60% of smear-positive patients

Percentage of Culture-Confirmed Pulmonary TB Cases Detected within 48 hours by NAAT in Wisconsin



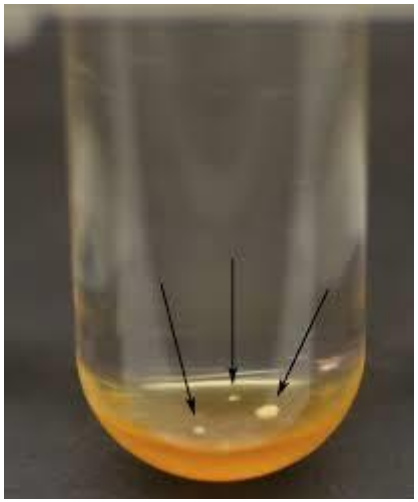
Mycobacterial Culture

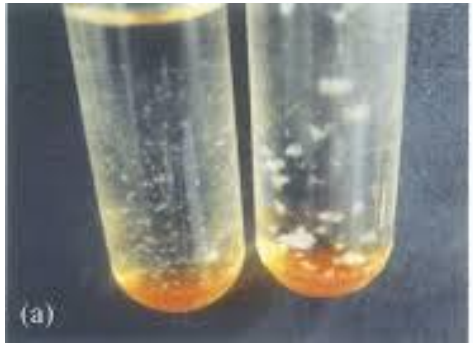
- Used to detect viable mycobacteria from patient specimens
- Most sensitive method for mycobacterial detection ("Gold Standard")
  - ~ 10 viable bacilli/ml for culture compared to >5000 bacilli/ml for microscopy
- Slowest method
  - Average time to detection for MTBC = 15 days
  - Range for detection of MTBC = 8-30+ days

Mycobacterial Culture

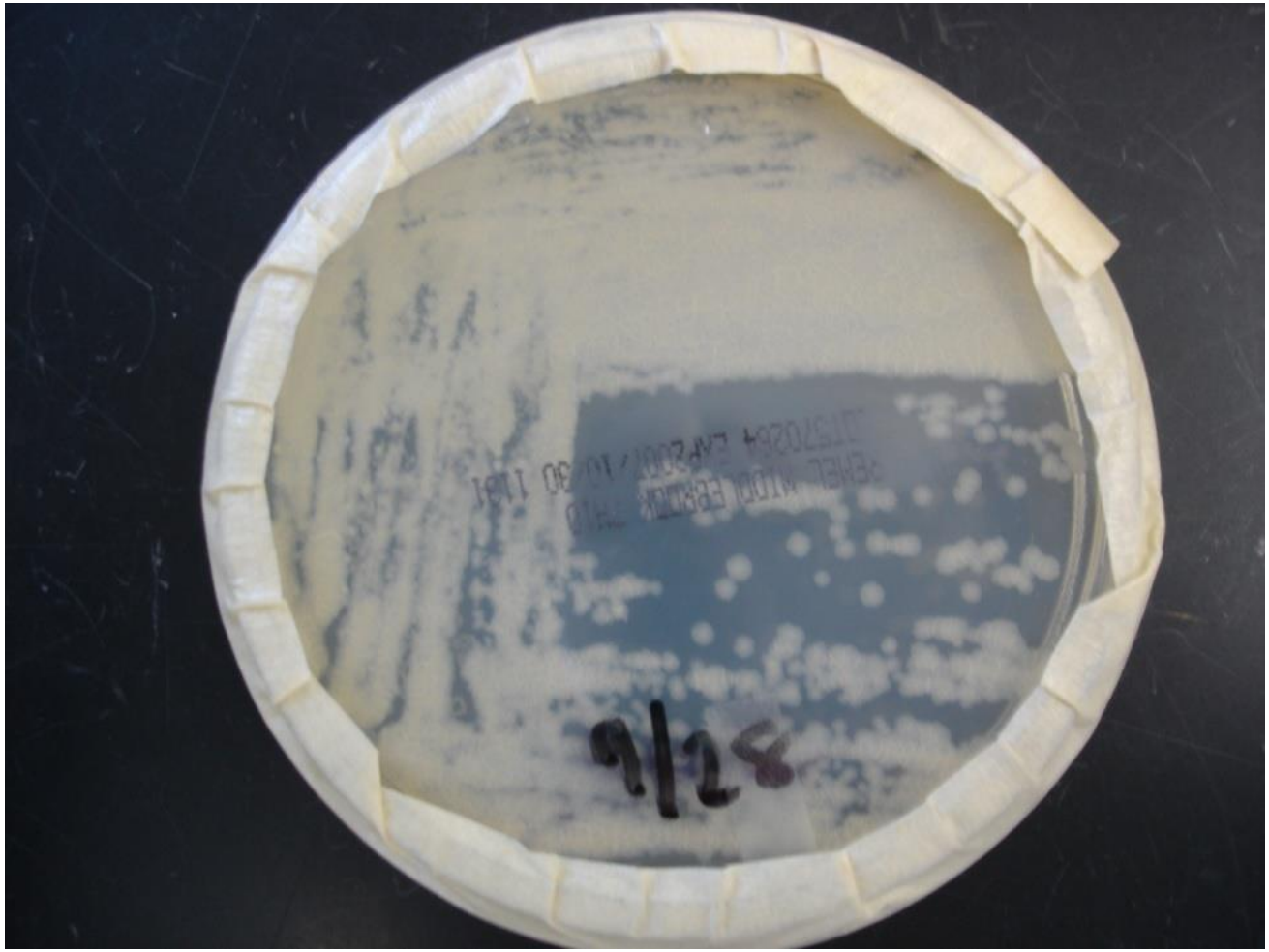
Media	Incubation
Broth "MGIT" tube—Mycobacteria Growth Indicator Tube	• In automated instrument, read hourly for 42 days • O2 consumption detected through fluorescent pad
Solid Middlebrook 7H11 plate (only on non-respiratory and known TB patients)	• Visually inspected once per week for 6 weeks

Bactec MGIT 960





7H11 Plate



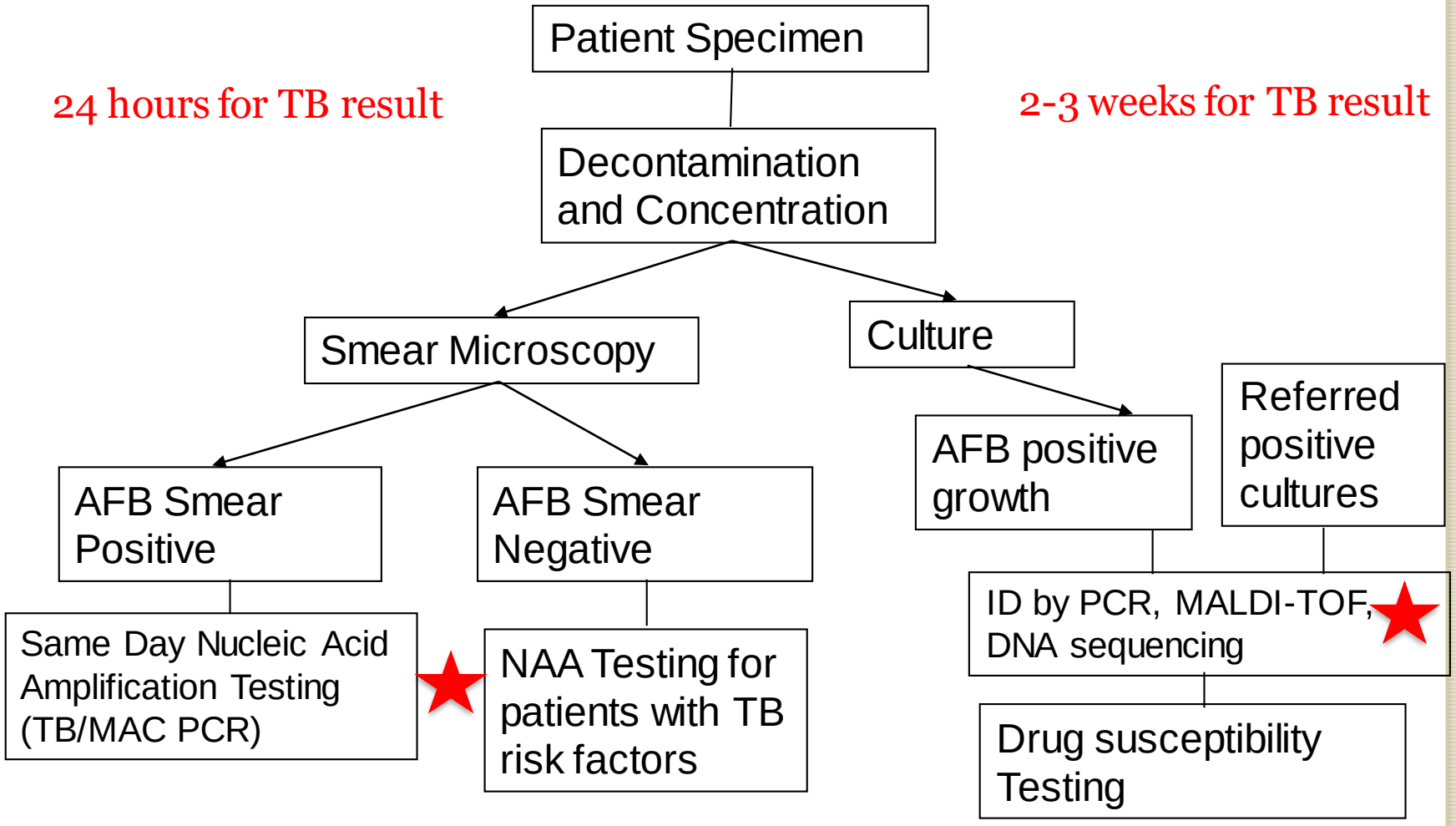
Mycobacteria ID Methods at WSLH

Method	Benefits	Limitations
TB or MAC PCR	• ID from scant growth • Rapid ID for >60% of new positive MGIT tubes	• Can only ID MTBC and *M. avium* complex
MALDI-TOF	• Good identification from solid media • Good ID of rapid growers	• Need good, pure growth • Extraction method • Poor ID from positive MGIT broth
DNA Sequencing	• "Gold standard", good ID to species level	• Labor intensive • Slow

Significance of MTBC culture results

- MTBC identification is the most important finding in the clinical mycobacteriology laboratory
  - MTBC is not found in the environment
  - Isolation of MTBC almost always signifies disease
- Necessary for species identification, drug susceptibility testing, genotyping
- Monitor patient response to treatment

Mycobacteriology Testing at WSLH



Drug Susceptibility Testing (DST) for MTBC

- Automatically performed on all new culture-confirmed TB-patients in WI
- Used as a guide in choosing treatment plan—provide the best chance of a cure
- Stop transmission of TB by ending infectious period as quickly as possible
- Initiate appropriate treatment for contacts

Culture-based Drug Susceptibility Testing

- WSLH is the only laboratory in the state that performs culture-based TB drug susceptibility testing
- Rarely, DST for a WI TB patient is performed at Mayo
- WI Statutes require that an isolate from each culture-positive TB patient be submitted to WSLH for DST, genotyping, and repository.

Culture-based Drug Susceptibility Testing

A.K.A. phenotypic or conventional DST

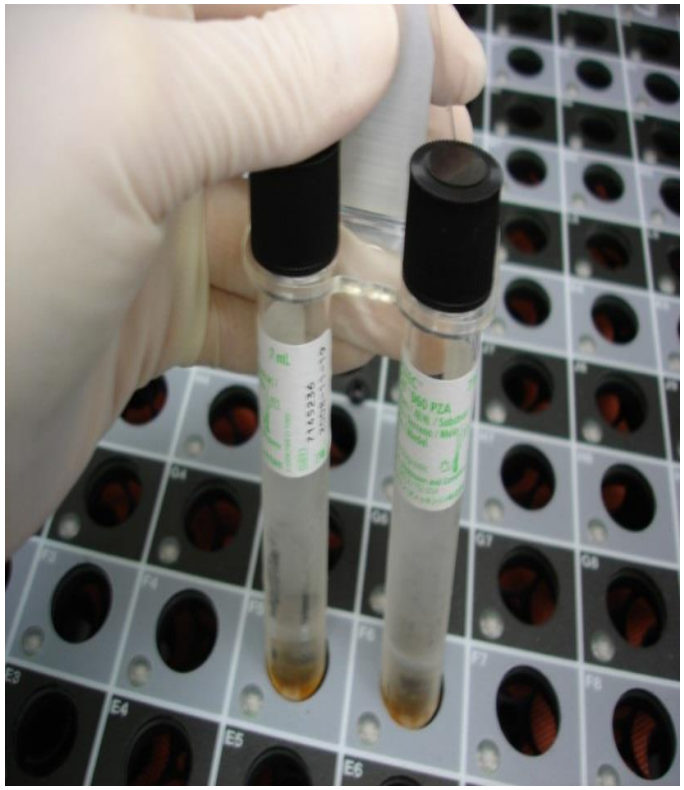
Principle: Incubate a known concentration of MTBC isolate with a known concentration of a drug and observe for growth, or inhibition of growth

First Line Drugs

MGIT 960 broth system

- INH (0.2 ug/ml)
- INH (1.0 ug/ml)
- rifampin (1.0 ug/ml)
- ethambutol (5.0 ug/ml)
- PZA (100 ug/ml)

- Confirm resistance by repeat testing

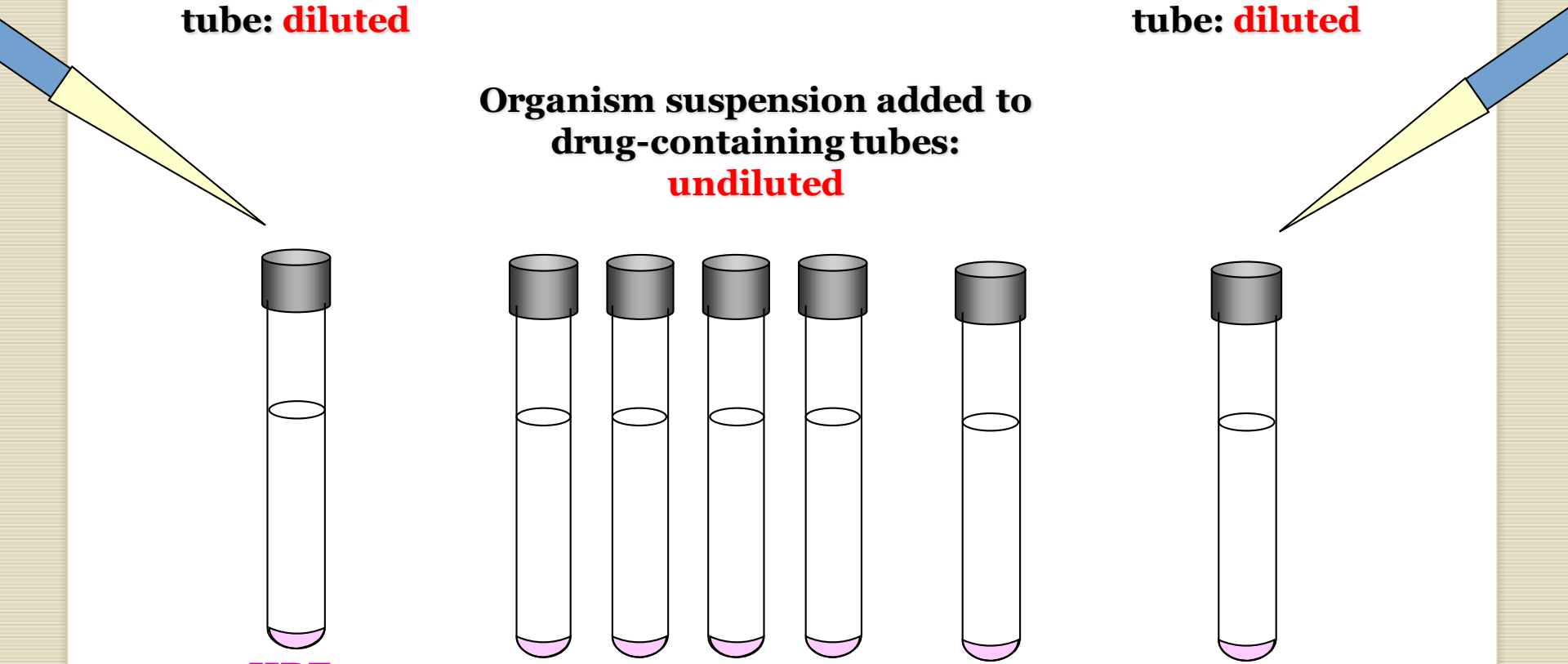


MGIT Method

Organism suspension added to drug-free tube: diluted

Organism suspension added to drug-free tube: diluted

Organism suspension added to drug-containing tubes: undiluted



IIRE Growth Control

INH low **INH high** **RMP** **EMB**

PZA

PZA Growth Control

Critical Concentration

Critical concentration is the lowest concentration of a drug that:

Inhibits growth of all susceptible strains

AND

Allows growth of all resistant strains

Growth of MTBC at critical concentration = RESISTANT

No Growth of MTBC at critical concentration = SUSCEPTIBLE

Interpretation of Drug Susceptibility Results

Result	Interpretation
Susceptible	Strain is likely to show responsiveness to the drug
Resistant	Strain is unlikely to show responsiveness to the drug
Indeterminate	Test is of no help in prediction of responsiveness to the drug

2-4 weeks after positive culture—How do we get quicker results?

Molecular Detection of Drug Resistance (MDDR) Testing

AKA: genotypic testing, DNA-based

Principle: Use DNA amplification and detection methods to identify specific gene mutations that are known to confer resistance to antituberculosis drugs.

Molecular Drug Susceptibility Testing

Advantages:

- Rapid turnaround time—result in 1-2 days vs. 2-3 weeks
- Test can be performed on mixed or non-viable cultures
- Characterization of new mutations

Disadvantages:

- Interpretation of uncommon or unknown mutations

Examples of Molecular DST

	Method		
	Cepheid GeneXpert® MTB/RIF	**Sanger Sequencing**	**Pyrosequencing**
Genetic loci	*rpoB* (for RMP)	Varies but can include *rpoB*, *inhA*, *katG*, *aphC*, *embB* (EMB), *pncA* (PZA), *gyrA* (FQ), and *rrs* (injectables)	Varies but can include *rpoB*, *inhA*, *katG*, *aphC*, *gyrA*, and *rrs*
Format	Semi-automated real-time PCR	DNA sequencing	DNA sequencing
FDA approved	Yes	N/A (laboratory developed test)	N/A (laboratory developed test)
Expected turnaround time from receipt in laboratory	1-2 working days	1-2 working days (depends on how often performed in lab)	1-2 working days (depends on how often performed in lab)

MDDR Testing at WSLH

- WSLH performs GeneXpert MTB/RIF assay on all new TB patients identified in WI (sputum sediment, BAL sediment, or broth culture—MGIT)
  - Any other specimen type is sent to CDC or Milwaukee City Public Health Department for testing
- Used as a rapid method to detect Rif-resistance/potential MDR TB

GeneXpert MTB/RIF

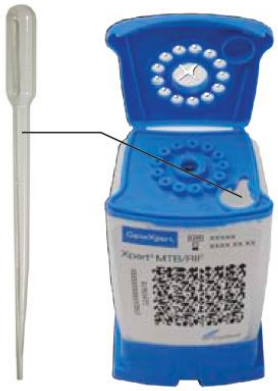
Workflow: Self contained cartridge – just add sample

Pour Sample Reagent into sample tube.

Incubate for 15 minutes at room temperature.
(Acceptable sample types: unprocessed sputum or sediment from concentrated specimen.)

1

Pipette diluted sample into cartridge.



2

Insert cartridge and start assay.

3

TOTAL HANDS-ON TIME = 2 MINUTES

GeneXpert Result Interpretation

Result	Interpretation
MTB DETECTED; Rif Resistance DETECTED	Likely Resistant to Rifampin
MTB DETECTED; Rif Resistance NOT DETECTED	Likely Susceptible to Rifampin

If RIF resistance mutation is detected, specimen is sent to CDC for full MDDR panel and 2nd line drug agar proportion testing

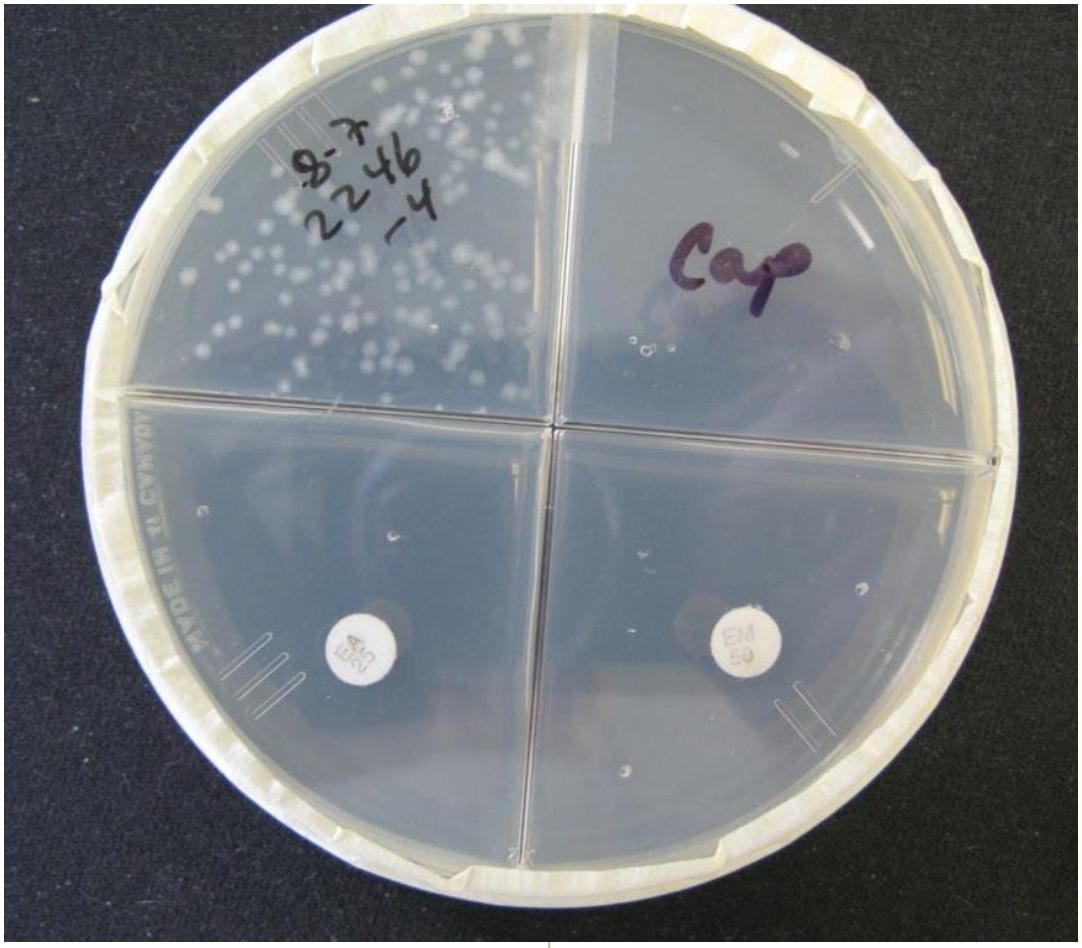
CDC MDDR Result Interpretation

Results for Molecular Detection of Drug Resistance (Sanger Sequencing, complete panel); Conventional Drug Susceptibility Test in progress.

Locus (region) examined*	Result	Interpretation (based on in-house evaluation of 550 clinical isolates)
rpoB (RRDR)	**Mutation:** TCG>TGG; Ser531Trp	Rifampin resistant. (100% of isolates in our in-house evaluation of 550 clinical isolates with this mutation are RMP-R.)
inhA (promoter)	No mutation	Cannot rule out INH resistance. (66% of INH-R isolates in our in-house evaluation of 550 clinical isolates have a mutation at one or both of these loci.)
katG (Ser315 codon)	No mutation	
embB (Met306,Gly406)	No mutation	Cannot rule out ethambutol resistance. (79% of EMB-R isolates in our in-house evaluation of 550 clinical isolates have a mutation at this locus.)
pncA (promoter. coding region)	No mutation	Cannot rule out PZA resistance. (86% of PZA-R isolates in our in-house evaluation of 550 clinical isolates have a mutation at this locus.)
gyrA (QRDR)	No mutation	Cannot rule out fluoroquinolone resistance. (80% of FQ-R isolates in our in-house evaluation of 550 clinical isolates have a mutation at this locus.)
rrs (1400 region)	No mutation	Cannot rule out resistance to injectable drugs (kanamycin, capreomycin, amikacin). (In our in-house evaluation of 550 clinical isolates: • 91% of AMK-R isolates have a mutation in the rrs locus; • 87% of KAN-R isolates have a mutation in either the rrs locus or the eis locus; • 55% of CAP-R isolates have a mutation in either the rrs locus or the tlyA locus.)
eis (promoter)	No mutation	
tlyA (entire ORF)	No mutation	

*A negative result (e.g., no mutation) does not rule out contributory mutations present elsewhere in the genome.

Agar Proportion Method



***3 weeks incubation at 35-37C**

AP Result Interpretation

Susceptibility Testing Method: Indirect agar proportion, 7H10 medium; Susceptibility is defined as < 1% resistance compared to colonies that develop on drug-free media

RESULTS:

	Percent Resistance	***Interpretation***		***Percent Resistance***	***Interpretation***
Isoniazid 0.2 ug/ml	0%	S	Kanamycin 5.0 ug/ml	0%	S
Isoniazid 1.0 ug/ml	0%	S	Ethionamide 10.0 ug/ml	0%	S
Isoniazid 5.0 ug/ml	0%	S	Capreomycin 10.0 ug/ml	0%	S
Rifampin 1.0 ug/ml	100%	R	PAS 2.0 ug/ml	0%	S
Ethambutol 5.0 ug/ml	0%	S	Ofloxacin 2.0 ug/ml	0%	S
Streptomycin 2.0 ug/ml	0%	S	Amikacin 4.0 ug/ml	0%	S
Streptomycin 10.0 ug/ml	0%	S			
Rifabutin 2.0 ug/ml	50%	R			
Ciprofloxacin 2.0 ug/ml	0%	S			

Susceptibility Testing Method: MGIT 960

Pyrazinamide 100 ug/ml : Susceptible

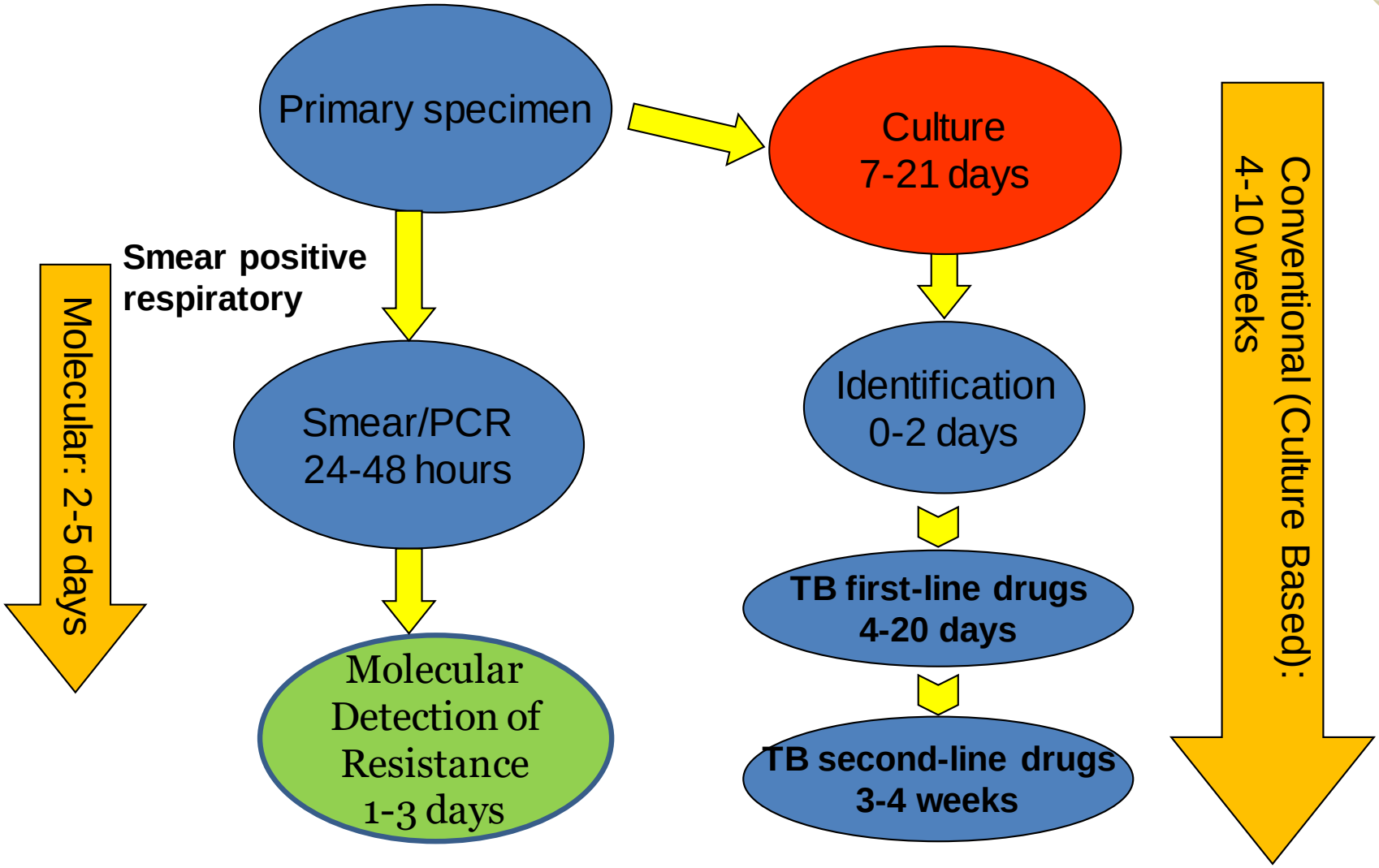
Comments: Molecular Detection of Drug Resistance (MDDR) report was issued 6/27/2017.

These conventional agar proportion results agree with the MDDR results.

Agar Proportion Limitations

- Slow---3 week incubation
  - Compared to 4-12 days with broth method
- Media preparation—cannot purchase commercially
- CDC goal
  - Report RIF DST result within 17 days of organism ID (impossible to meet!)

Turn around Times



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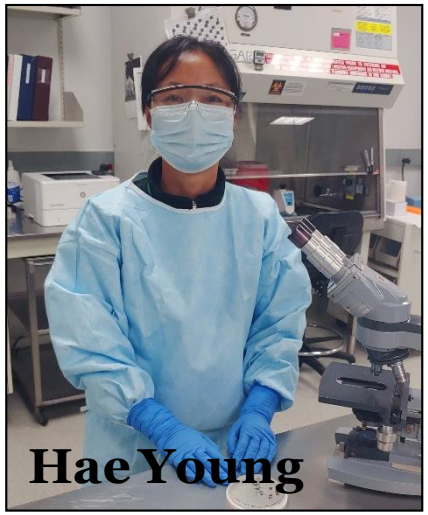
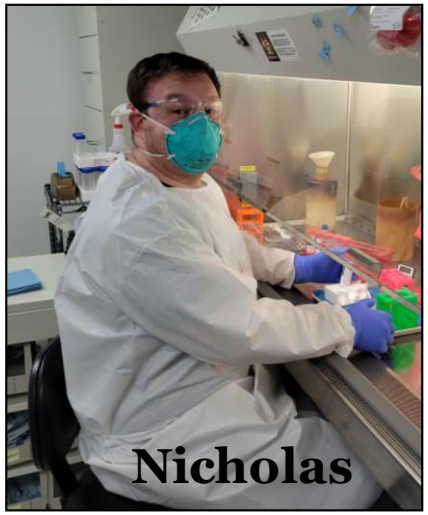
The WSLH TB Laboratory Staff

WSLH TB Laboratory Team





Questions?

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