

Tuberculosis: Transmission and Pathogenesis

Christopher Vinnard, MD, MPH, MSCE
Clinical Assistant Professor
New Jersey Medical School
Rutgers, The State University of New Jersey

RUTGERS

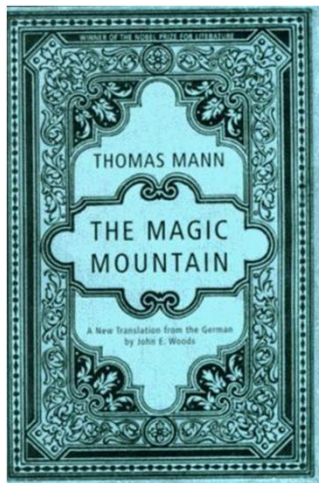
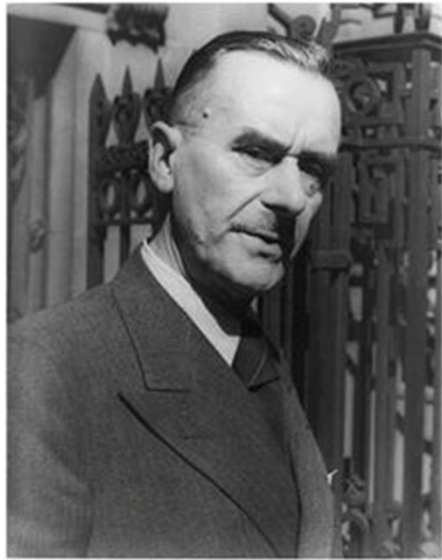
1



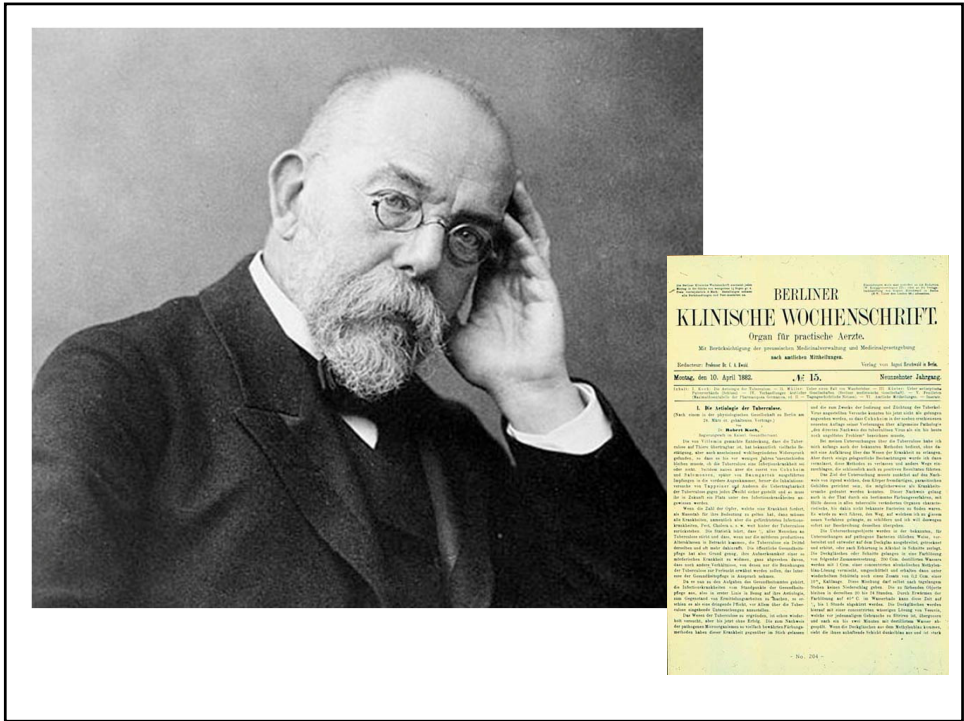
2



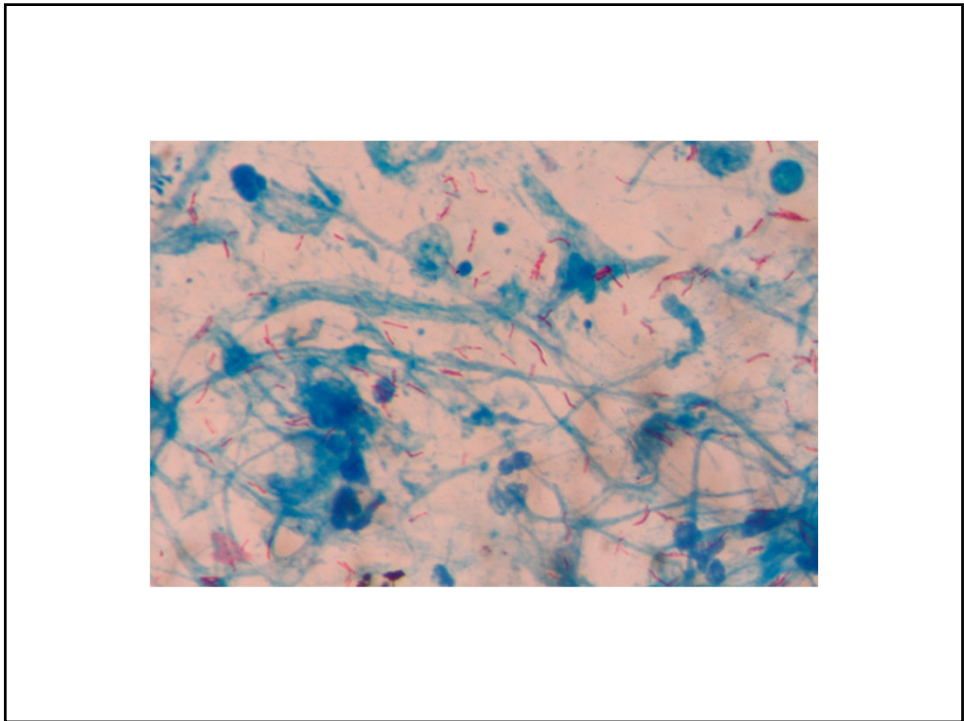
3



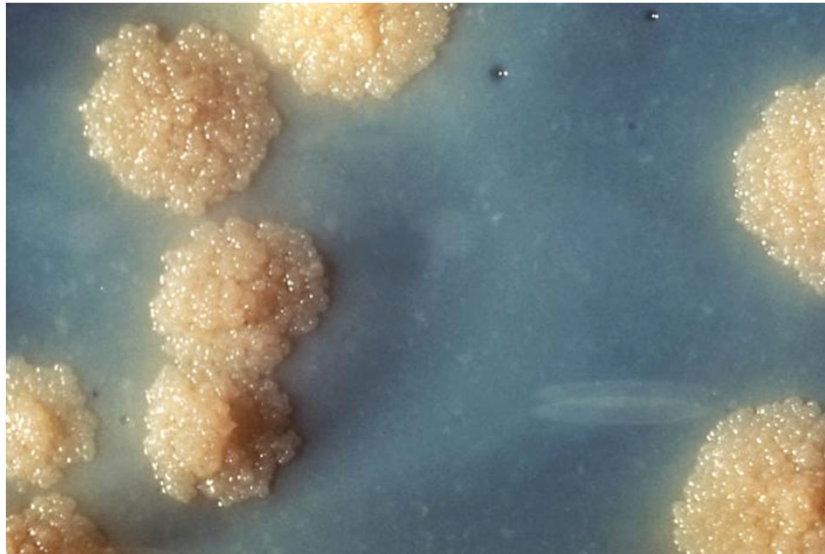
4



5



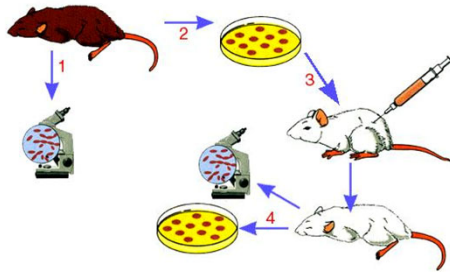
6



7

1. The pathogen must be present in all cases of disease.

2. The pathogen can be isolated from diseased host and grow in pure culture.



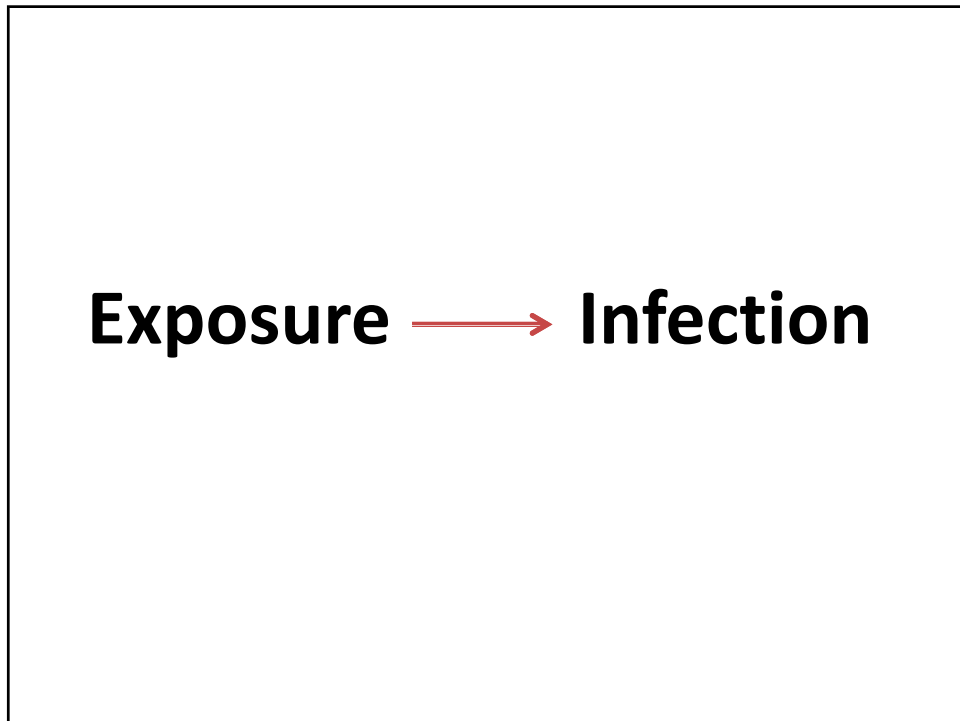
3. The pathogen from the pure culture must cause the disease when inoculated into a healthy, susceptible laboratory animal.

4. The pathogen must be reisolated from the new host and shown to be the same as the originally inoculated pathogen.

8

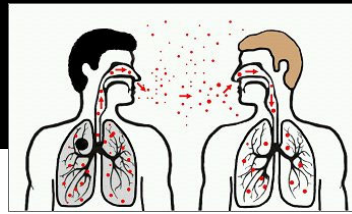


9



10

Airborne vs. Droplet



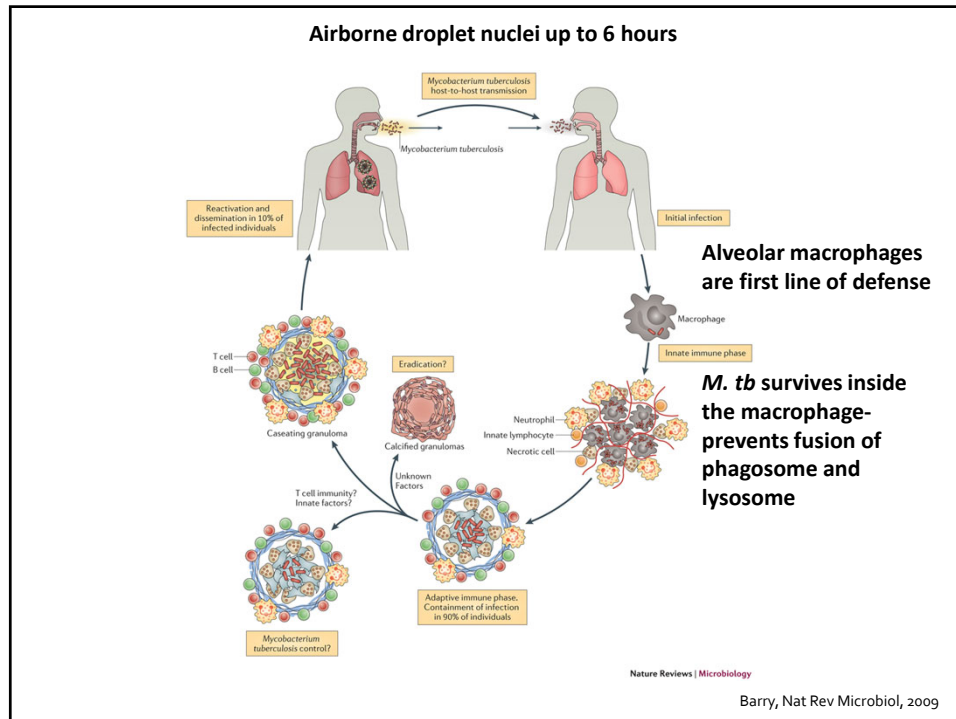
DROPLET

- Transmission within meter of source
- Inoculum typically has large numbers of organisms
- Access to vulnerable sites in oropharynx and upper airway
- Hand washing may be effective

AIRBORNE

- Transmission within shared breathing space
- Inoculum may have small numbers of organisms
- Access to vulnerable sites in alveoli
- Hand washing not effective

11



12

Innate vs. Adaptive Immunity

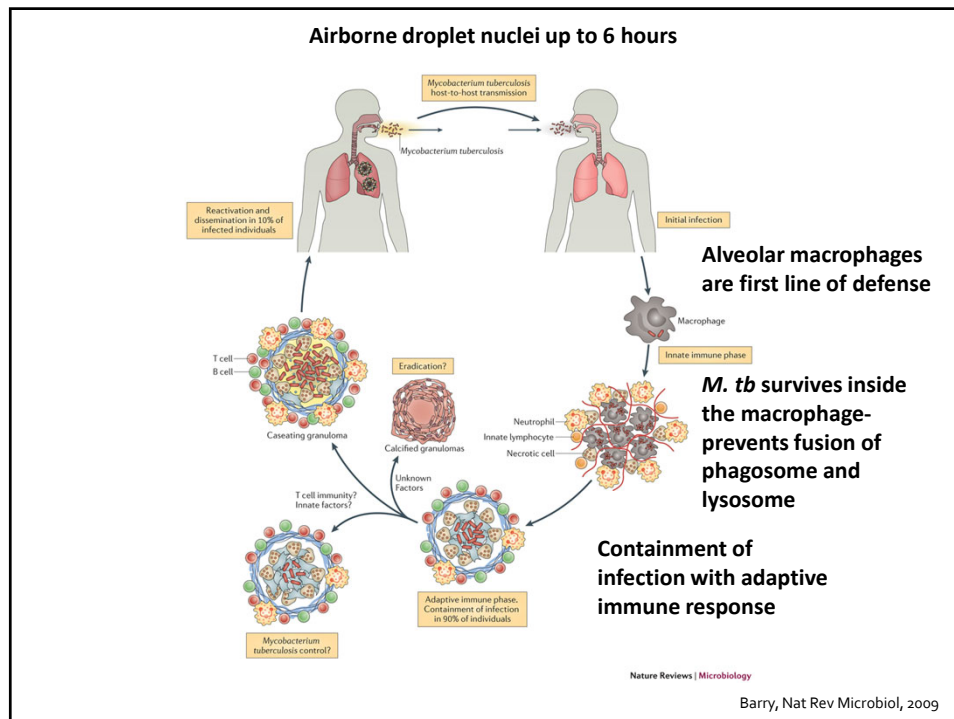
INNATE

- Nonspecific factors- within hours of exposure
- Triggered by chemical properties of the antigen
- Chemokines attract circulating monocytes, transform into macrophages

ADAPTIVE

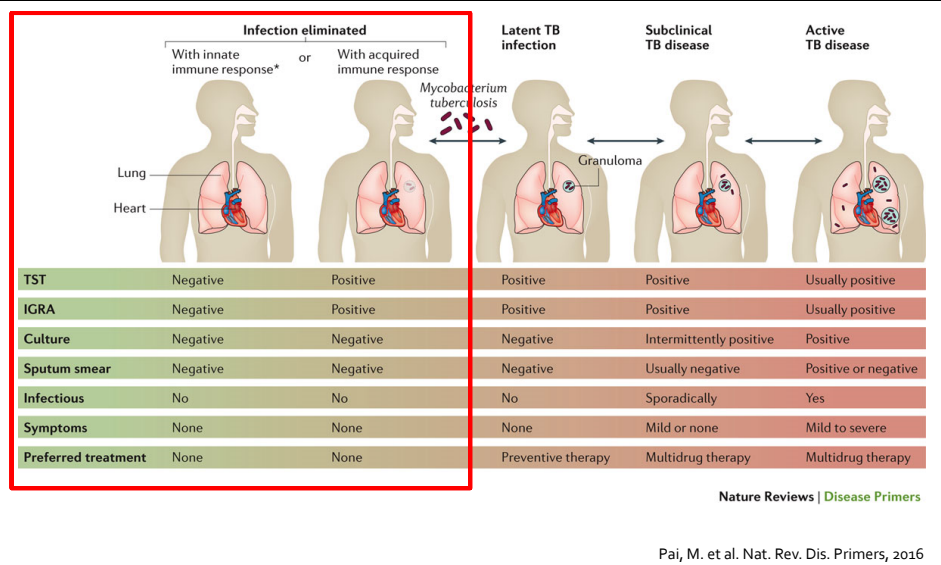
- Antigen specific immune responses
- Slowly develops in TB infection
- Delayed response may contribute to latency

13

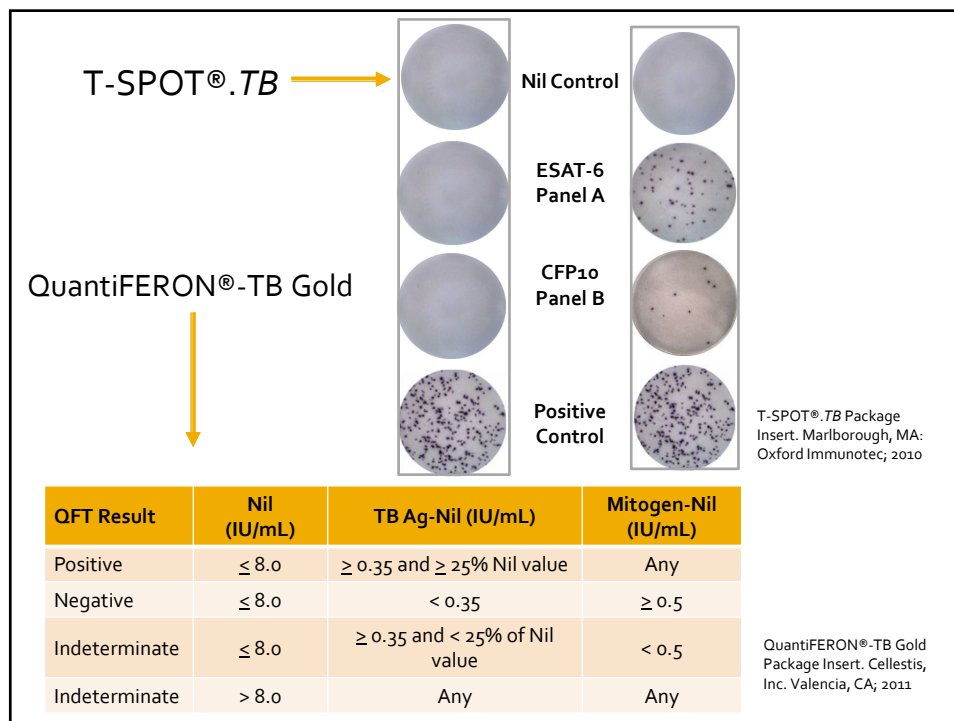


14

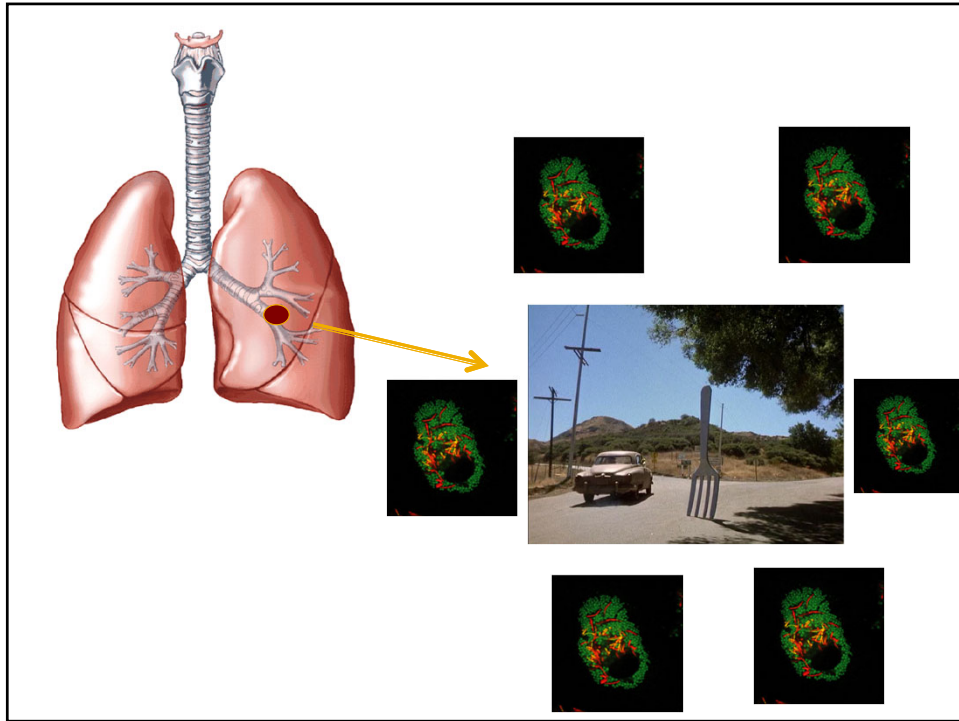
The Spectrum of TB: From *M. tuberculosis* Infection to Active (pulmonary) TB Disease



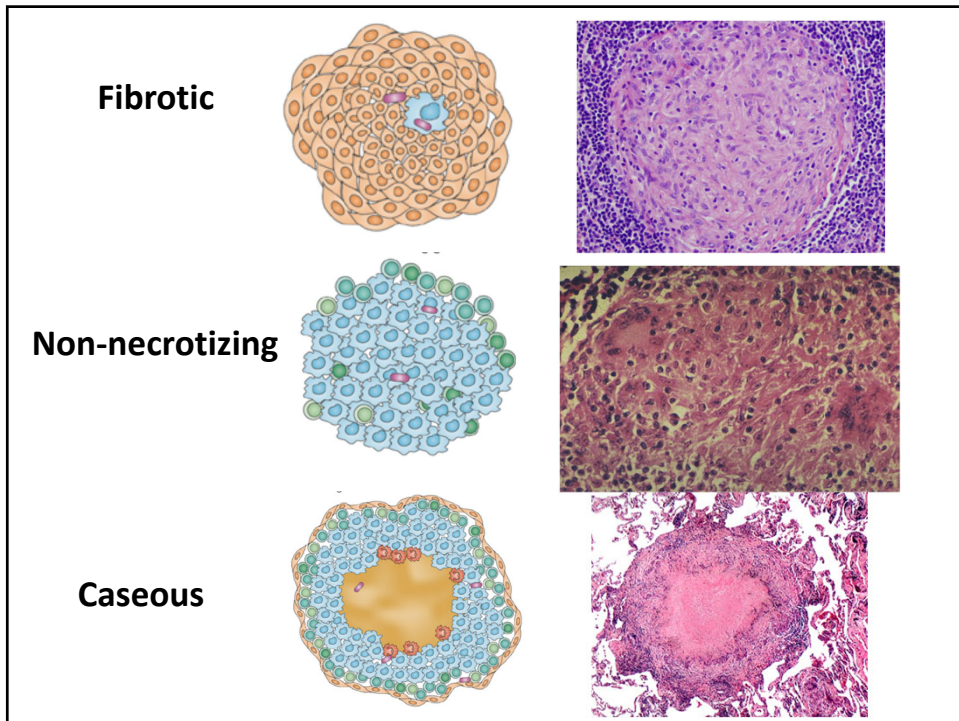
15



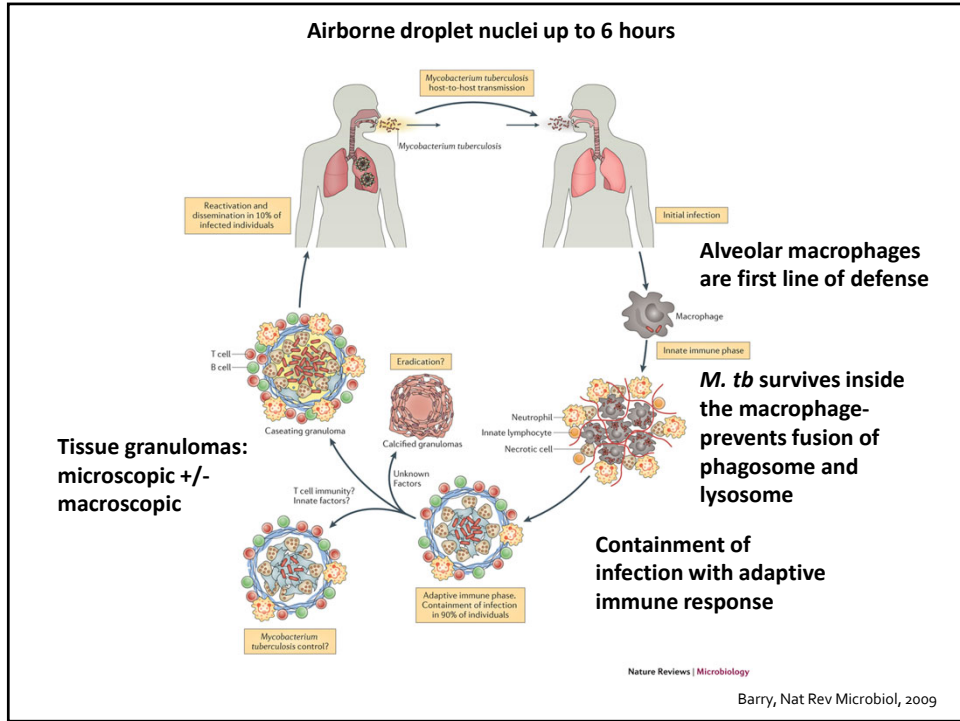
16



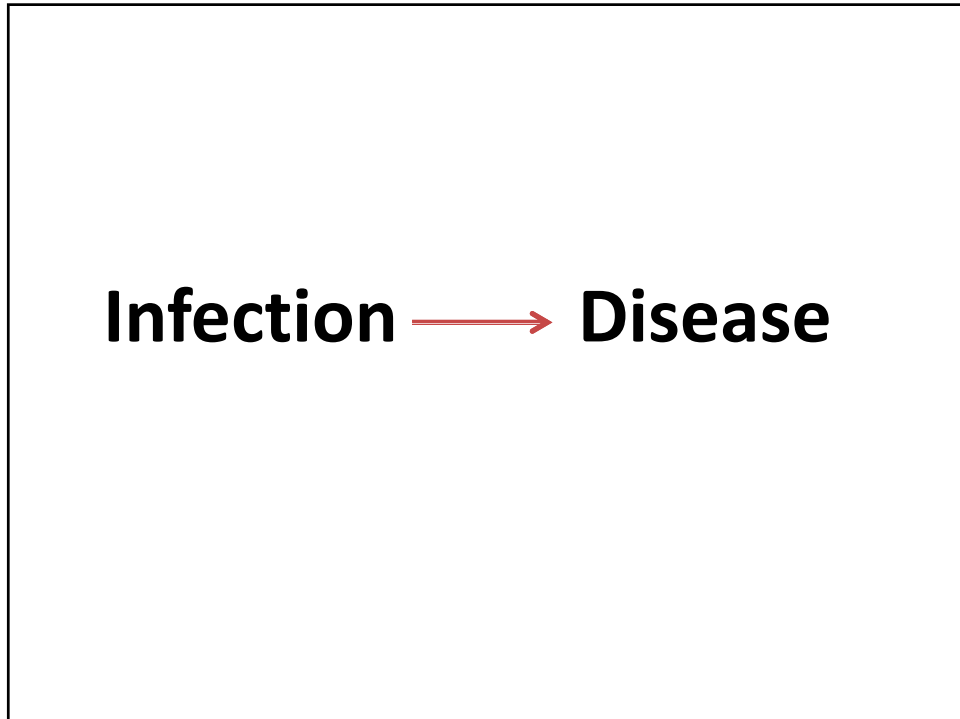
17



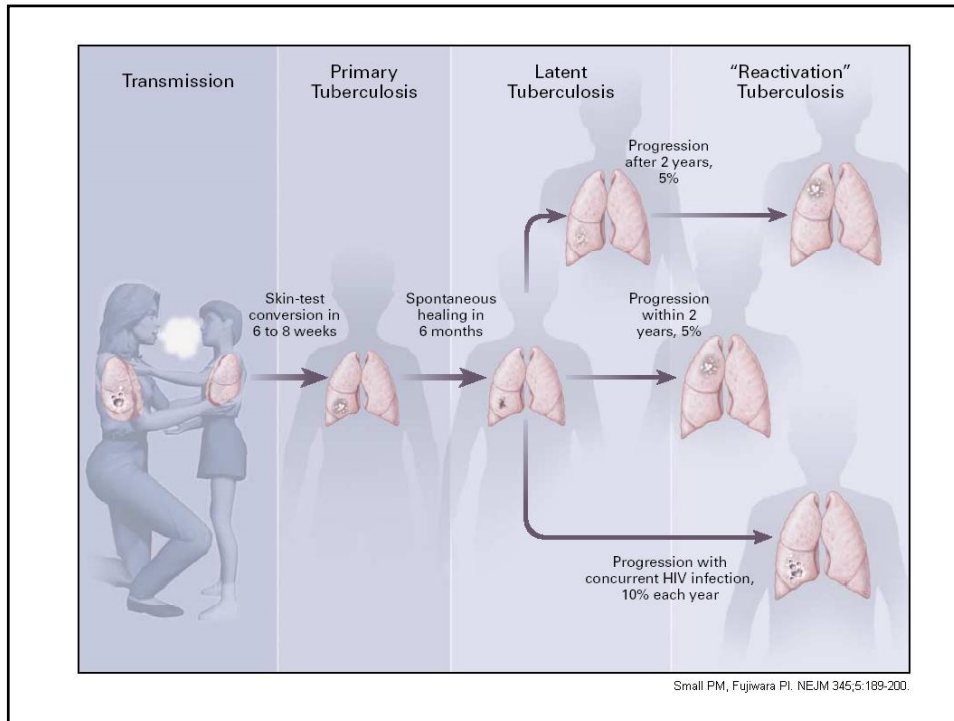
18



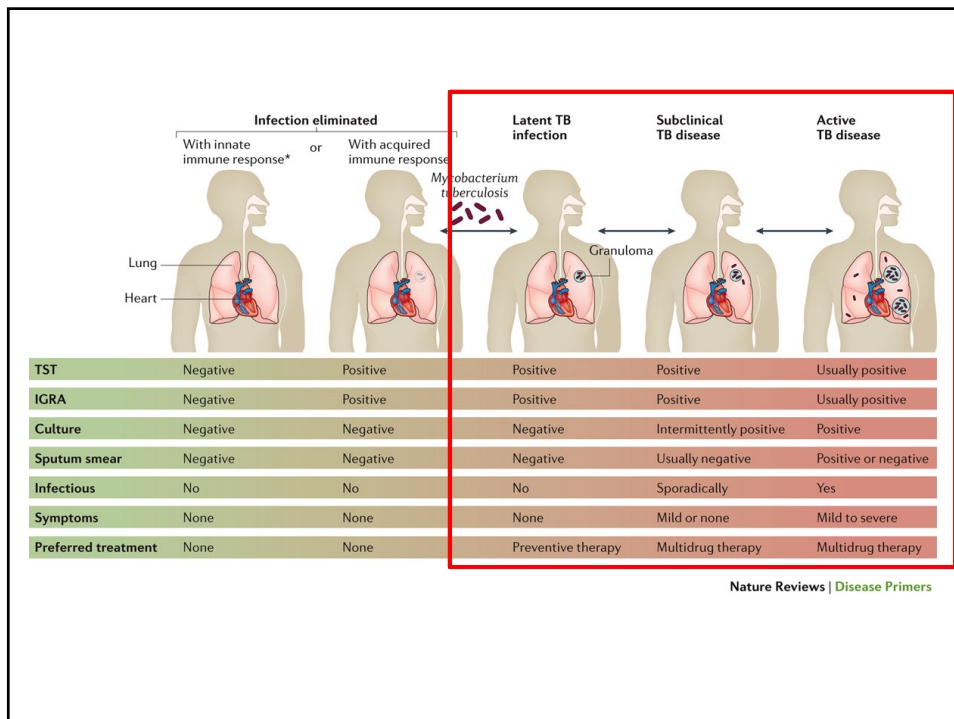
19



20



21

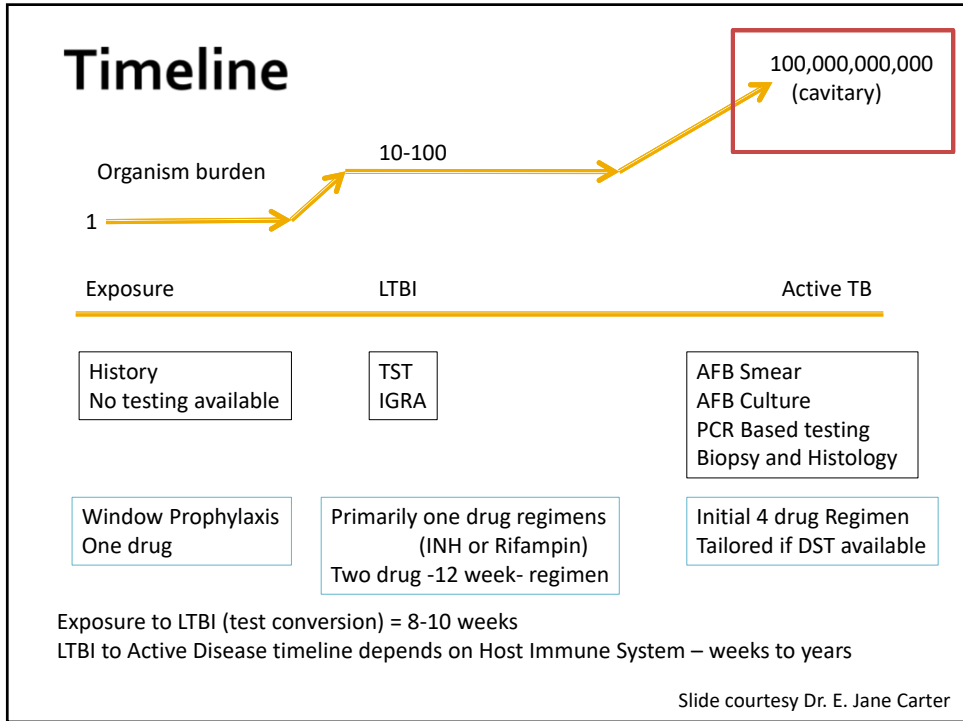


22

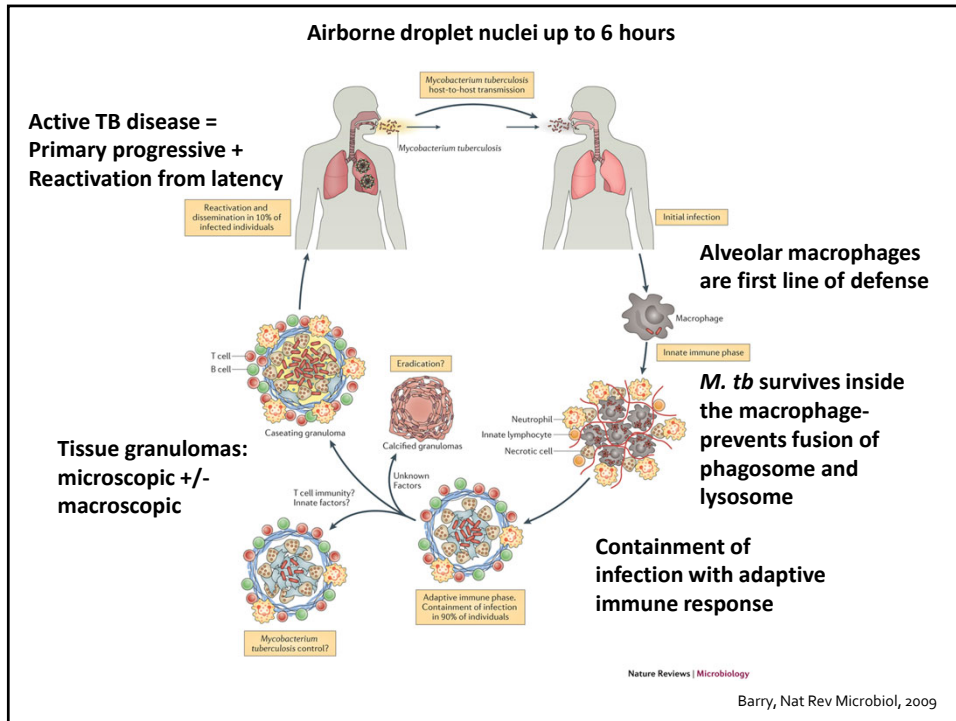
Risk Factor and Study	Relative Risk (95% CI)
	%
Advanced HIV	
Advanced, untreated HIV infection Moss et al. ¹⁰	9.9 (8.7–11)
Pablos-Méndez et al. ¹⁹	9.5 (3.6–25)
Close contact	
Close contact with a person with infectious tuberculosis†	
Ferebee ¹⁷	6.1 (5.5–6.8)
CXR evidence of old TB (untreated)	
Radiographic evidence of old, healed tuberculosis that was not treated	
Ferebee ¹⁷	5.2 (3.4–8.0)
Chronic renal disease	
Treatment with ≥15 mg of prednisone per day‡	
Jick et al. ¹⁸	2.8 (1.7–4.6)
Chronic renal failure	
Pablos-Méndez et al. ¹⁶	2.4 (2.1–2.8)
TNF-alpha inhibitor	
Treatment with TNF-α inhibitor	
Asking et al. ¹⁹	2.0 (1.1–3.5)
Poorly controlled DM	
Poorly controlled diabetes	
Pablos-Méndez et al. ¹⁶	1.7 (1.5–2.2)
Underweight	
Weight ≥10% below normal	
Palmer et al. ²⁰	1.6 (1.1–2.2)
Smoking	
Smoking	
Bates et al. ²¹	1.5 (1.1–2.2)

NEJM 2011; 364(15): 1441-8

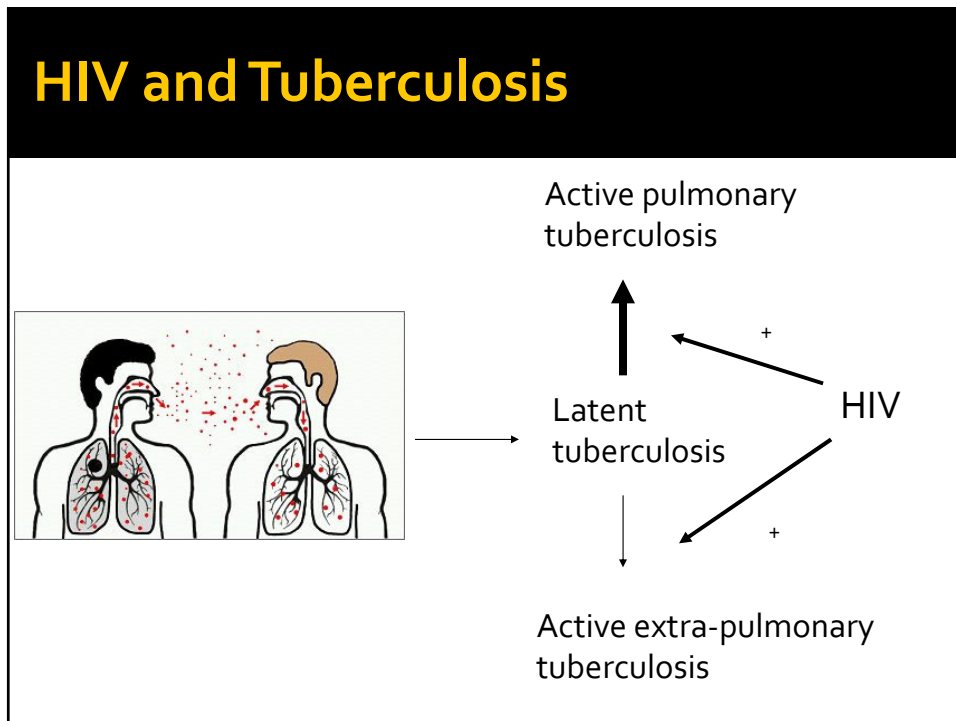
23



24

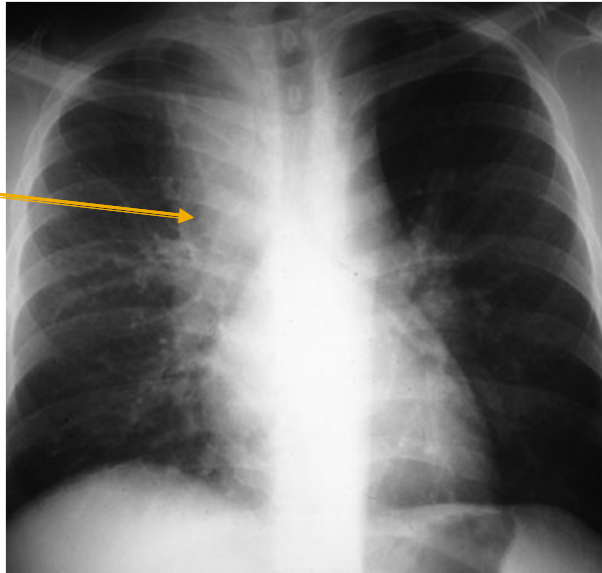


25



26

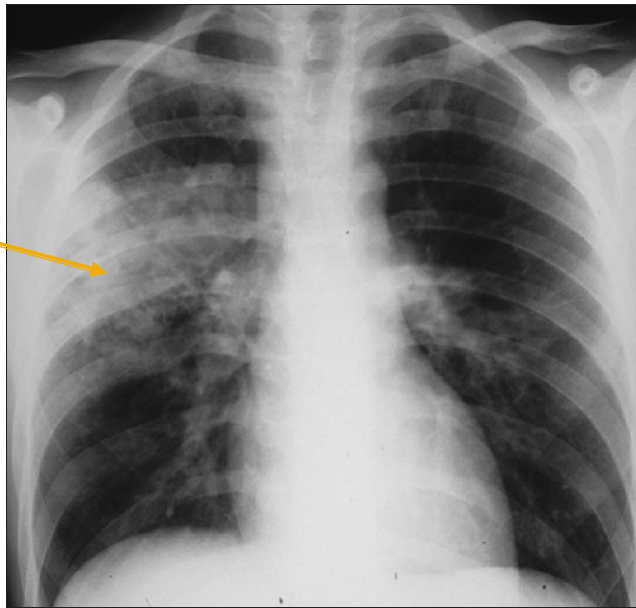
Paratracheal and hilar lymphadenopathy



<http://www.hiv.va.gov/provider/image-library/tb.asp?post=1&slide=46>

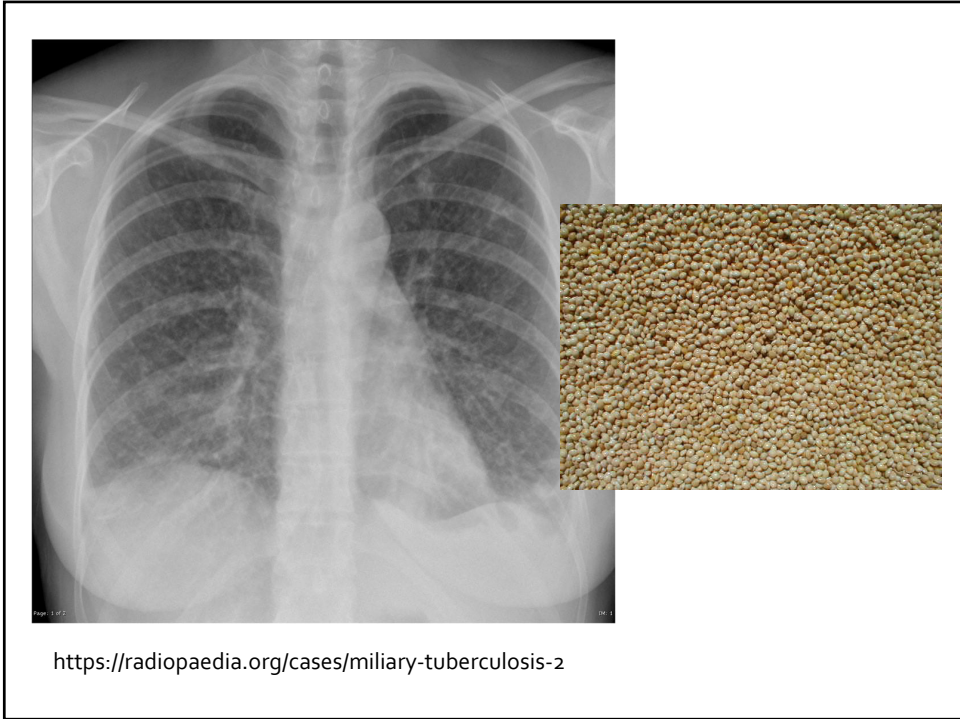
27

Right upper lobe consolidation

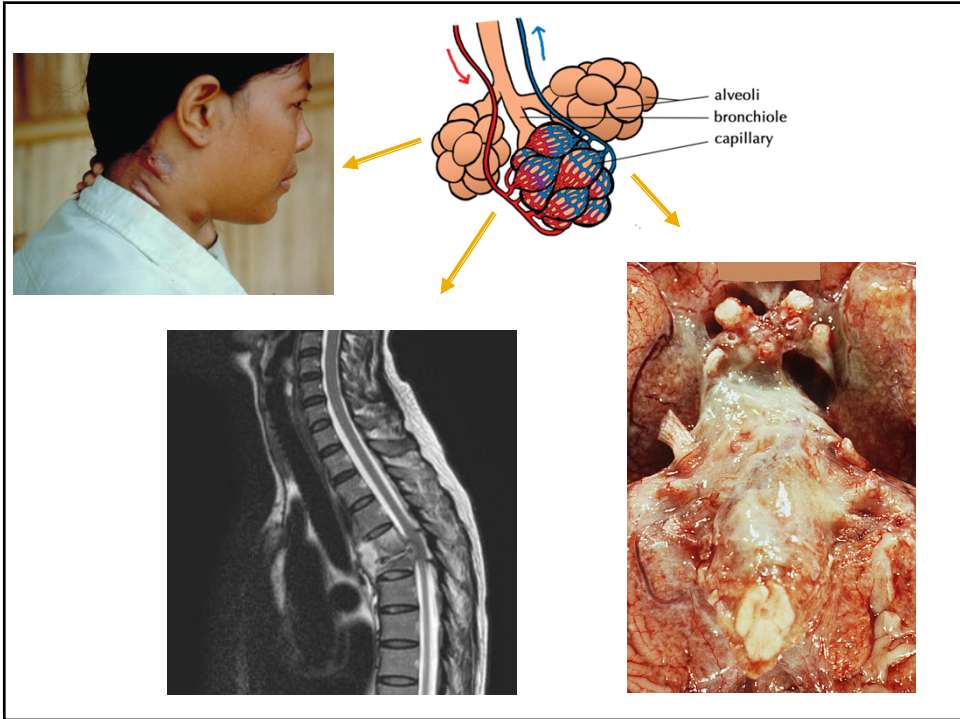


Annals of Thoracic Medicine - Vol 5, Issue 4, October-December 2010

28

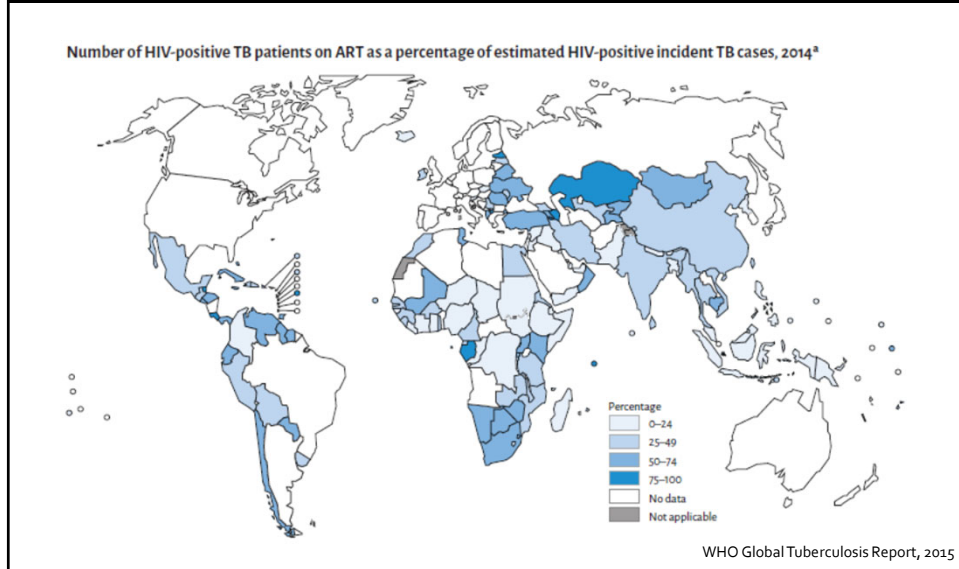


29



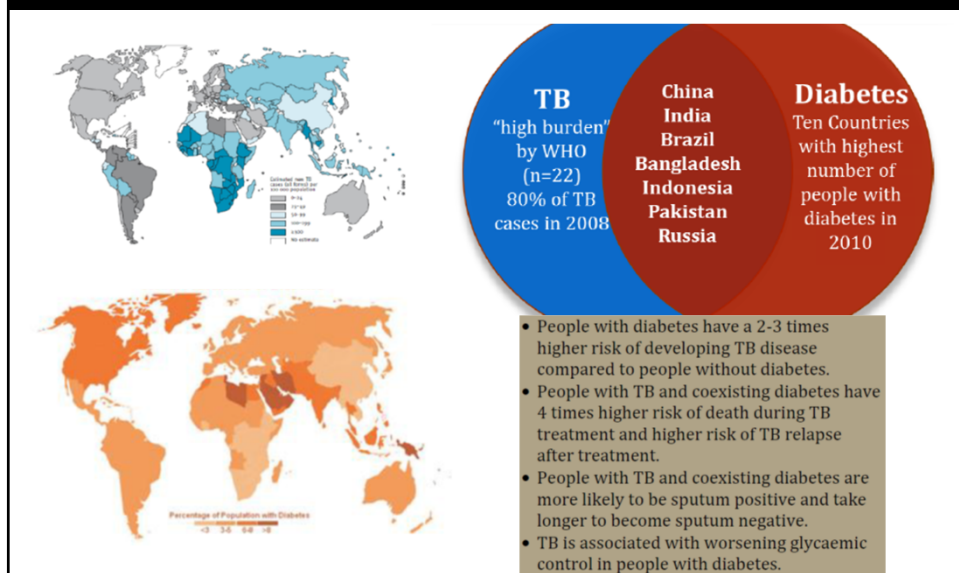
30

Number of HIV+ TB Patients on ART as a Percentage of Estimated HIV+ Incident TB Cases, 2014



31

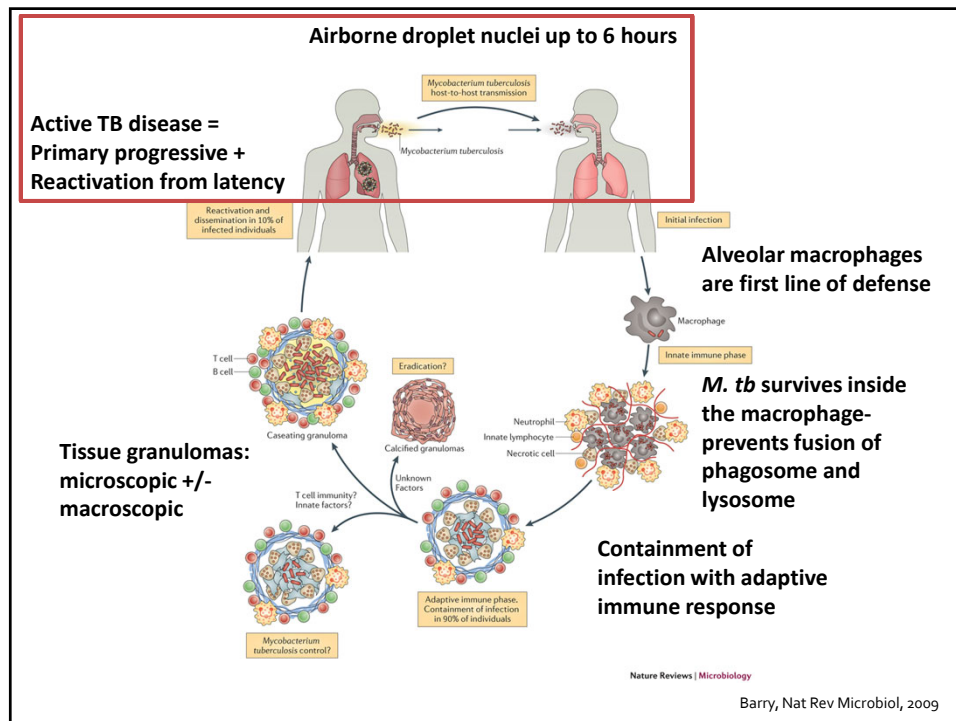
Diabetes and Tuberculosis



32

Disease → Contagion

33

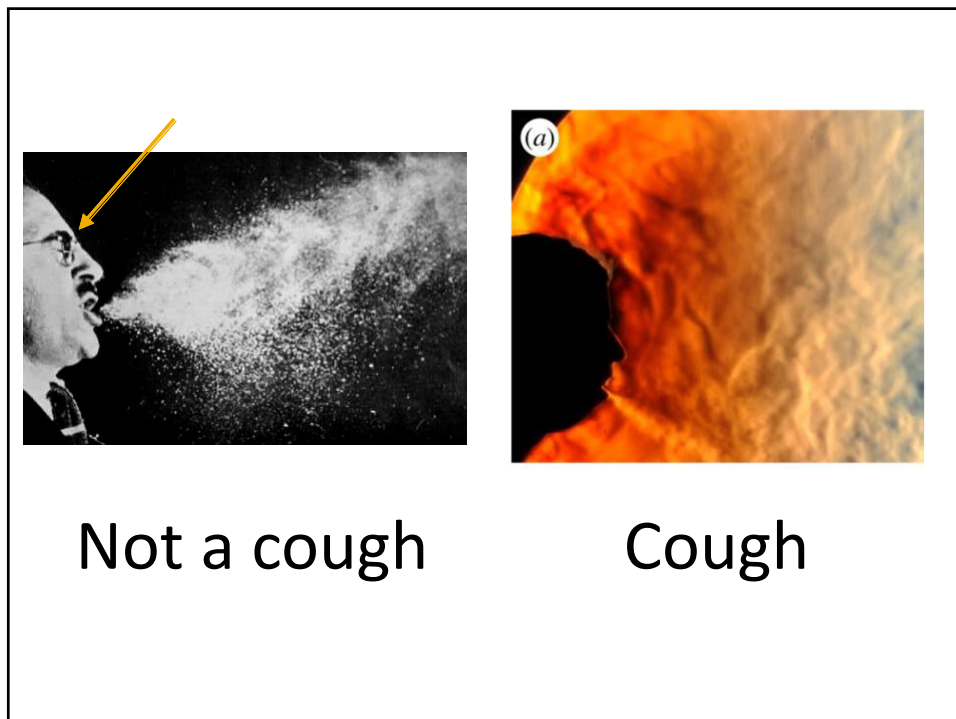


34

Factors That Influence Transmission

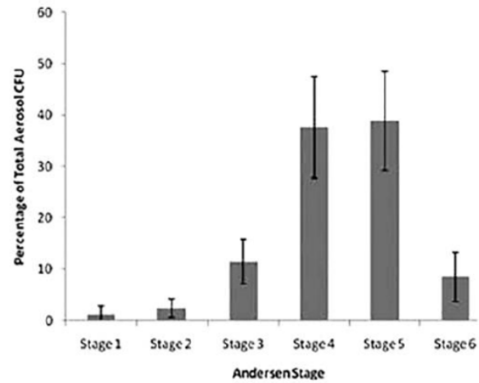
- Infectiousness of index patient (source)
 - Cough
 - Smear microscopy grade
 - Cavitory disease
- Duration of exposure
- Virulence of *M. tuberculosis* strain
- Environment of exposure
 - Room size, air circulation

35



36

TB Transmission by Cough Aerosols



Lower limit of size range (μ)	7.0	4.7	3.3	2.1	1.1	0.65
Anatomical deposition	Upper airway	--	bronchi	--	alveoli	

Fennelly 2015

37

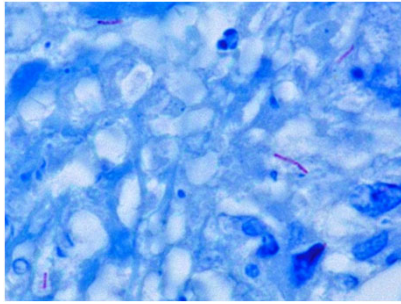
Hierarchy of Infection Control Measures to Prevent Nosocomial TB Transmission

- Administrative
 - Reduce risk of exposure
- Environmental
 - Prevent spread and reduce concentration of droplet nuclei
- Personal Respiratory Protection
 - Further reduce risk of exposure in special areas and circumstances

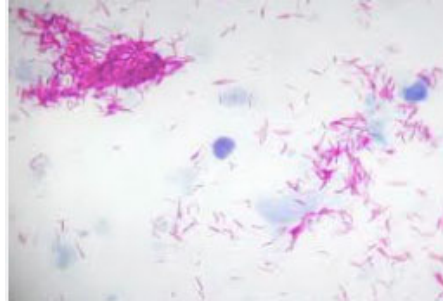
Slide courtesy Dr. E. Jane Carter

38

Less Transmission



More Transmission

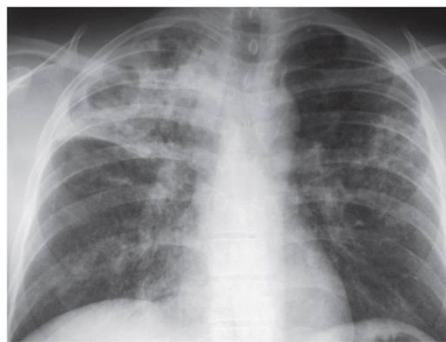


39

Less Transmission



More Transmission



40

Less Transmission



More Transmission



SAMJ, S. Afr. med. j. vol.102 n.8 Cape Town Aug. 2012

41

Reducing TB Transmission

- The best way to stop transmission is to:
 - Provide effective **treatment** to infectious persons as soon as possible
 - Decreases bacterial burden
 - Decreases symptoms
 - 2 weeks of effective therapy decreases contagion dramatically
 - **Isolate** infectious persons while contagious
 - Smear negative samples implies minimal contagion and allows for discontinuance of isolation
 - Zero transmission occurs once the index patient is culture negative

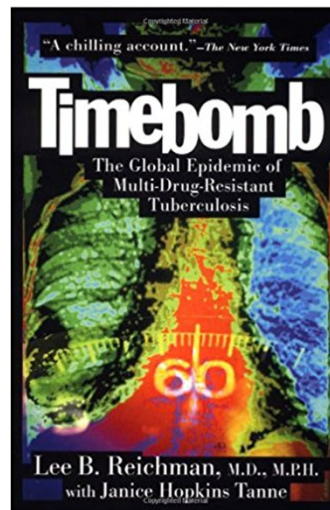
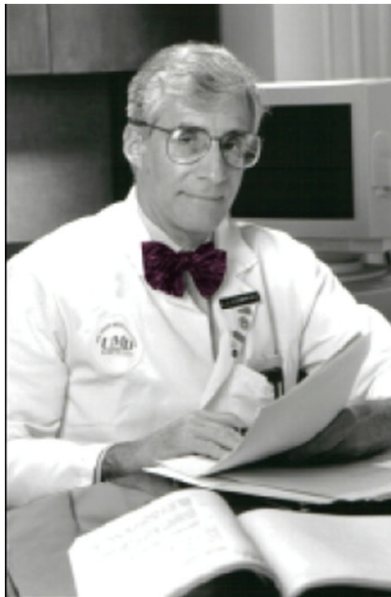
Slide courtesy Dr. E. Jane Carter

42

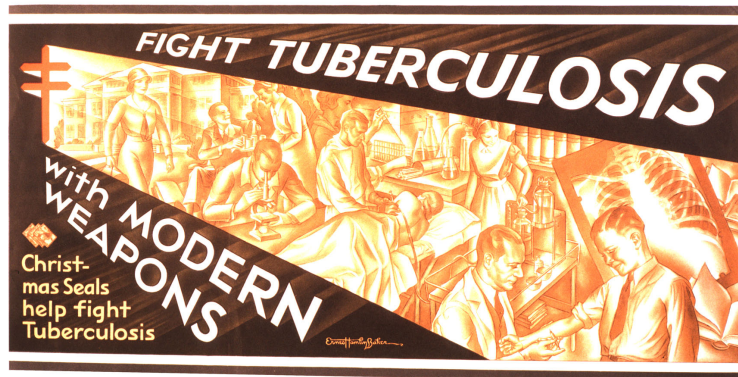


PATIENTS DANCE in a hallway at Sea View Hospital to demonstrate for a newspaper photographer how miraculously the drugs have restored their energy.

43



44



Thank you!

christopher.vinnard@njms.rutgers.edu