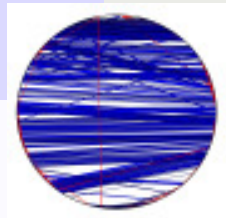


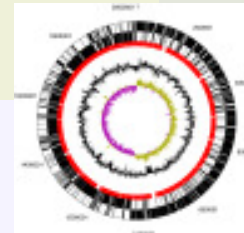
Genomics of *Streptococcus pneumoniae* and *Streptococcus mitis*

Regine Hakenbeck

Department of Microbiology and Nano+Bio Center
University of Kaiserslautern



NBC
Nano+Bio Center



 TECHNISCHE UNIVERSITÄT
KAISERSLAUTERN



patho-genomics

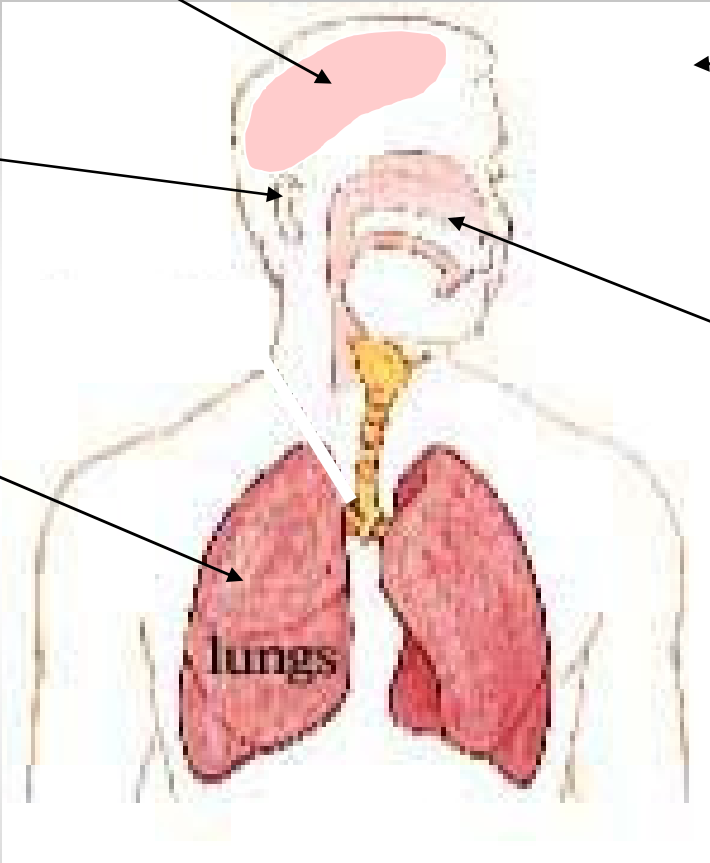
Meningitis

Sinusitis

Otitis

Colonizer of the Nasopharynx

Pneumonia



Sepsis

antibiotic resistance

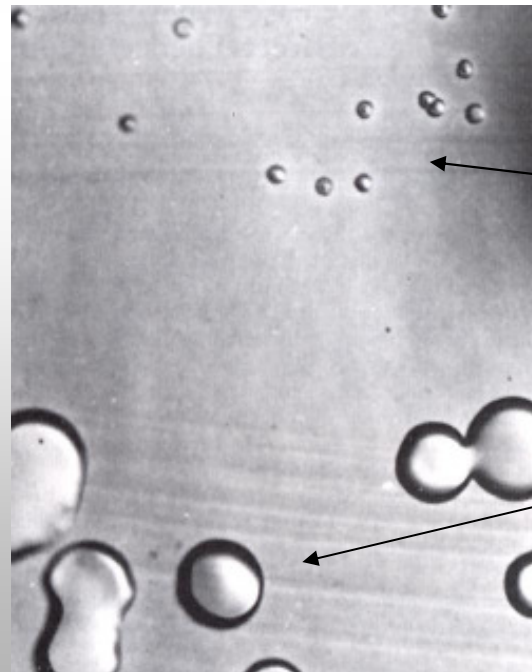


**Oswald Theodore
Avery
(1877-1955)**

The
Transforming
Principle



90 capsular types

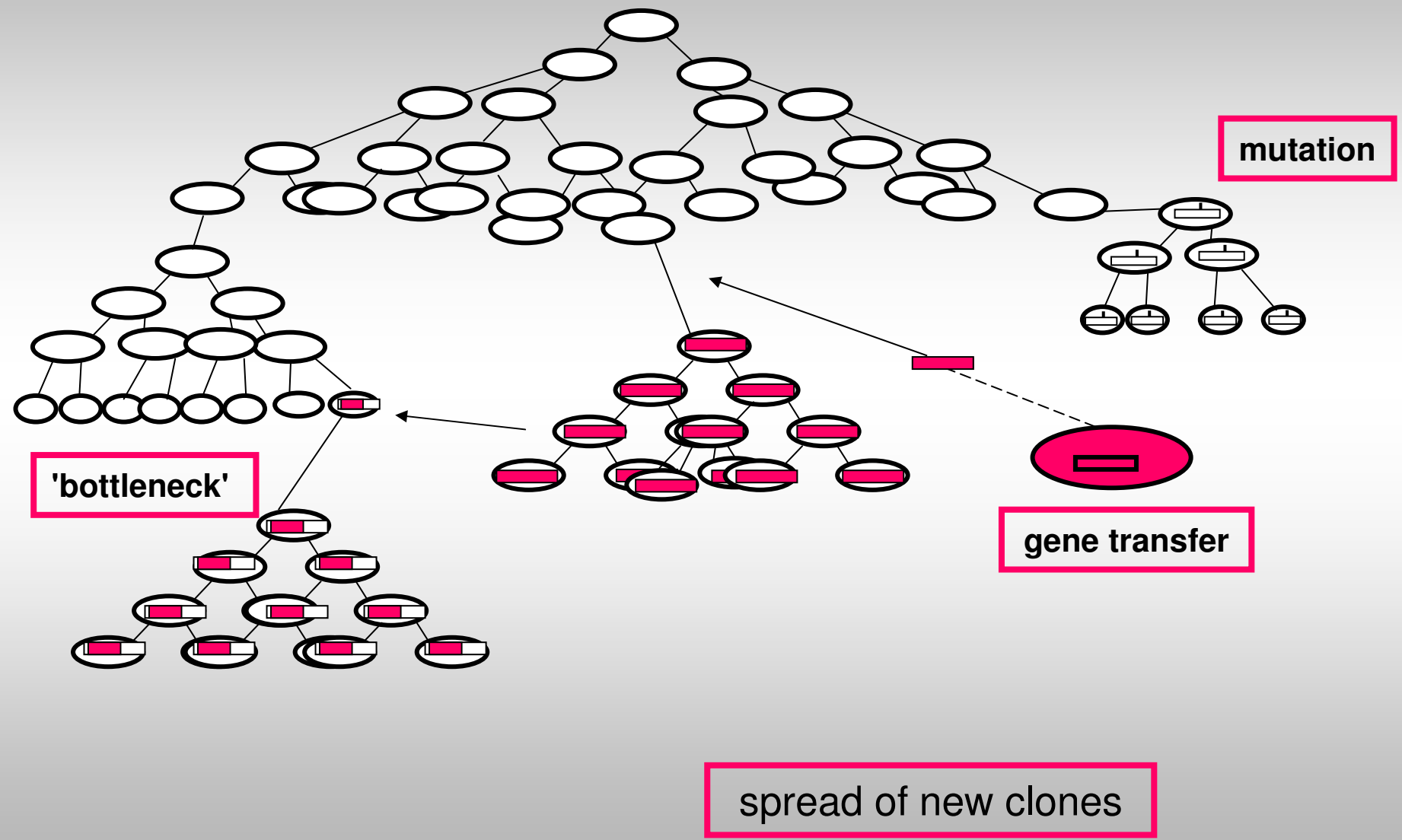


rough (*cps*⁺)

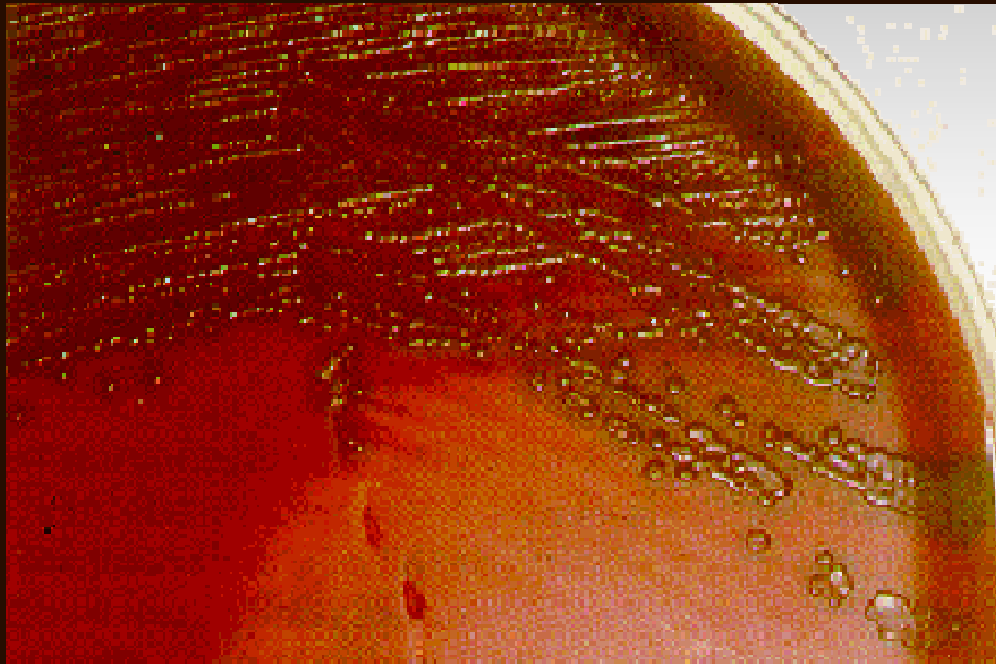
colonies

smooth (Δcps)

Intra- and interspecies gene transfer



S. mitis?
S. oralis?



Streptococcus pneumoniae
on blood agar plate

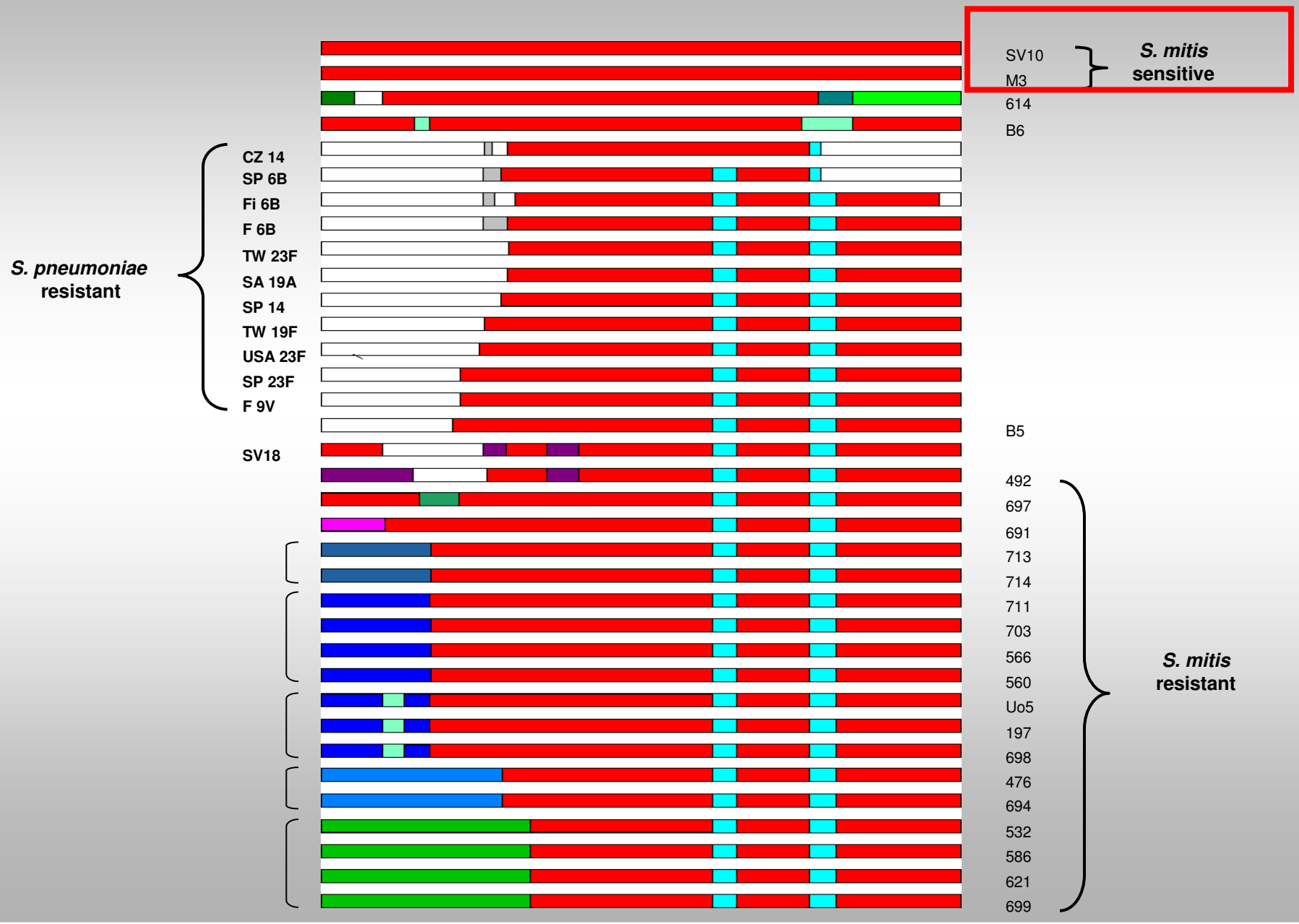
Genetic Evidence

of Gene Transfer

of Virulence



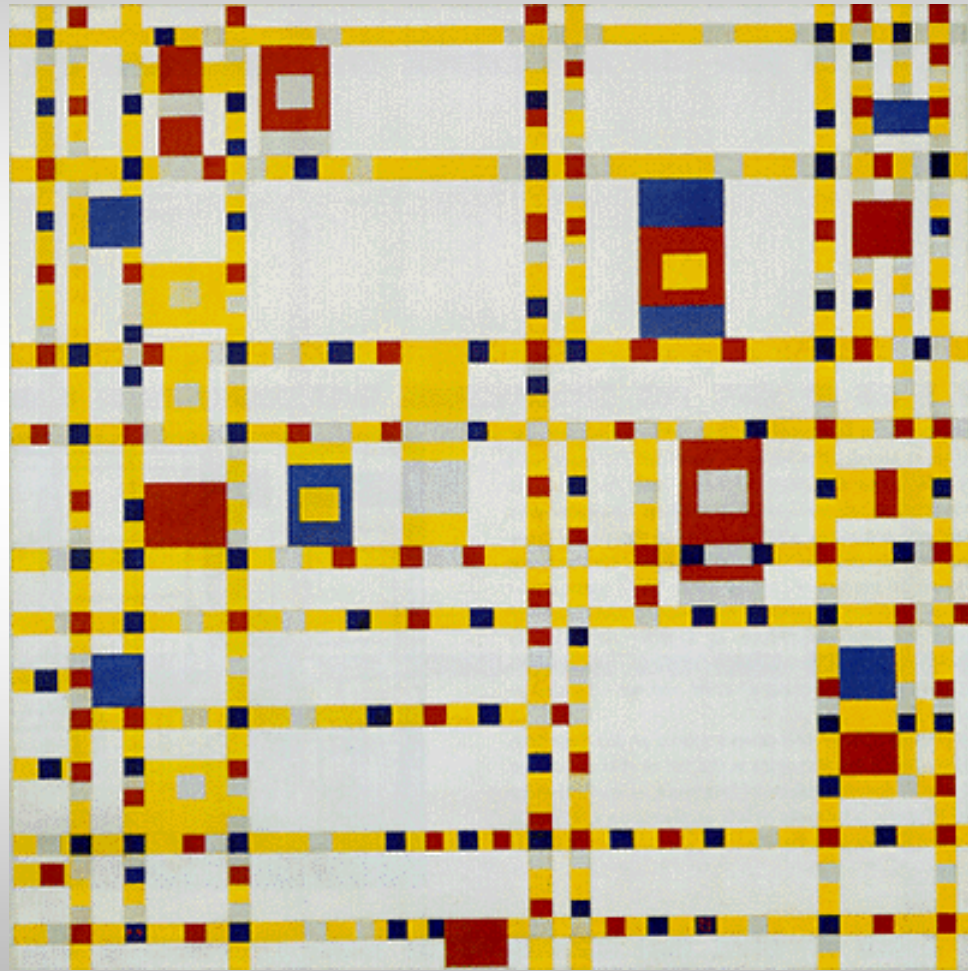
The success of one major class of mosaic *pbp2x* genes



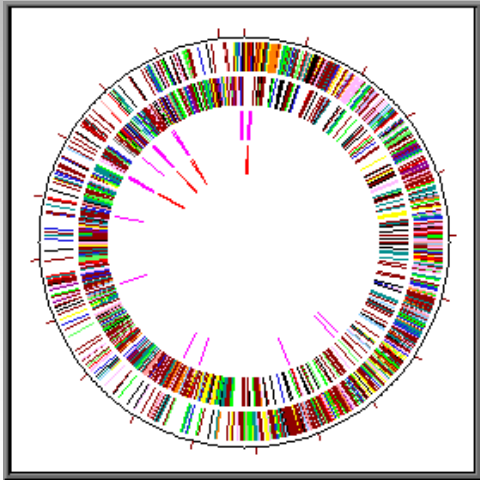
Penicillin resistance is mediated by highly diverse mosaic genes



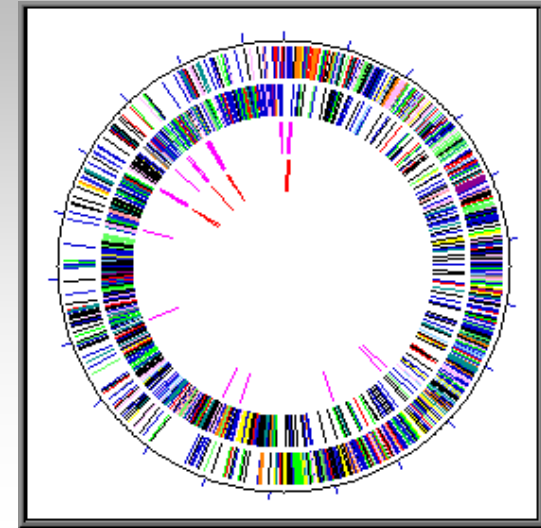
Mosaic Genes - Mosaic Chromosomes?



Genomes

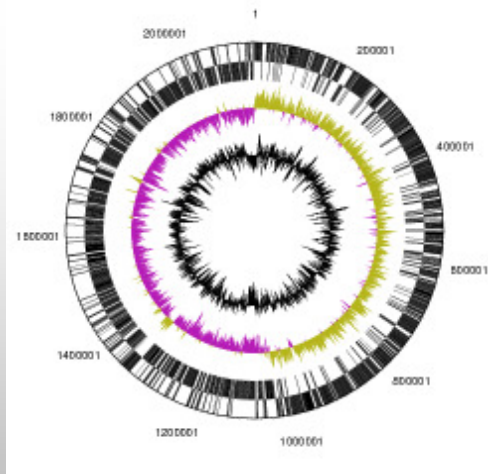


Streptococcus pneumoniae R6
2.04 Mb



Streptococcus pneumoniae TIGR 4
2.16 Mb

Pathogens



Streptococcus mitis B6
2.14 Mb

Commensals

Gene transfer

commensal

S. mitis

commensal

S. oralis

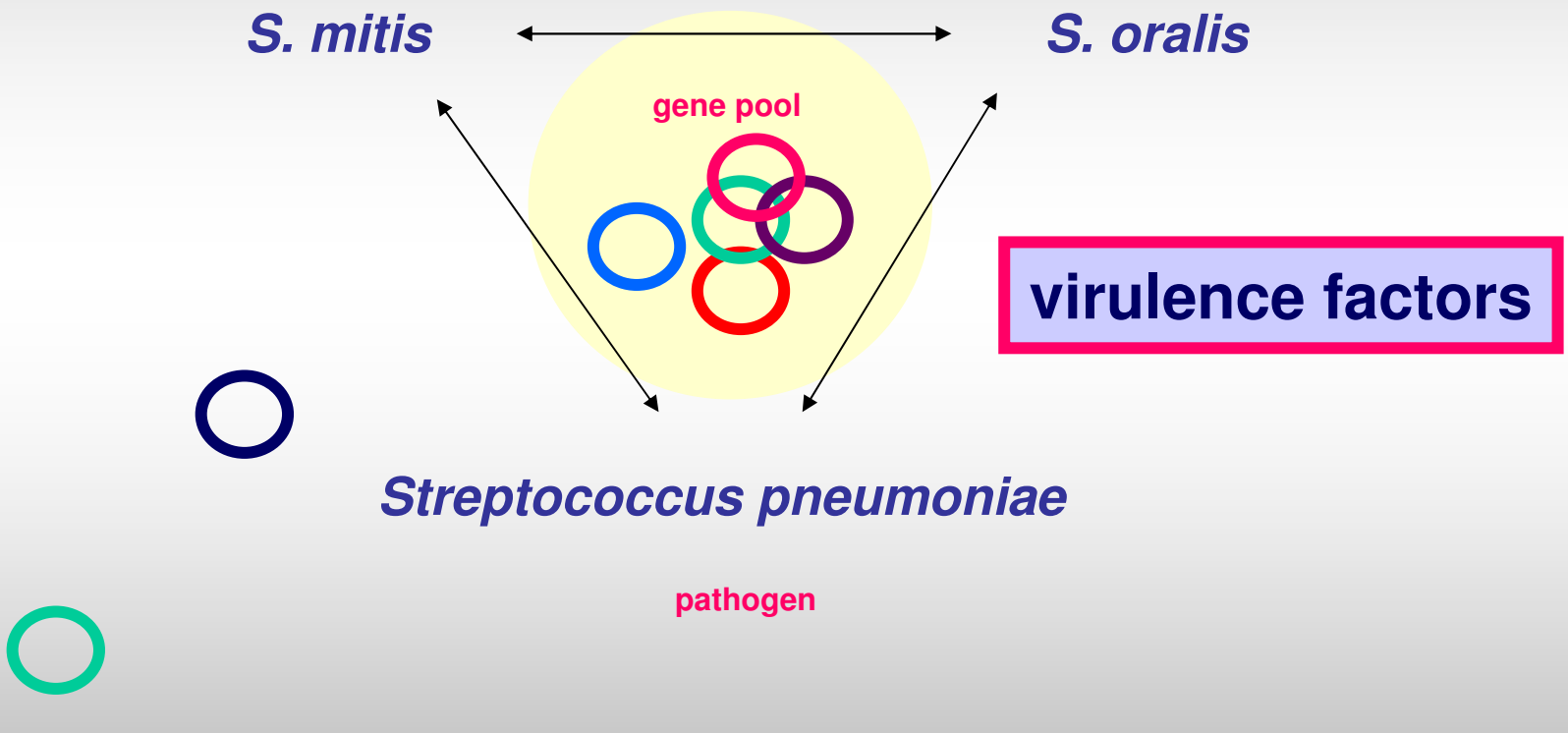
gene pool

virulence factors

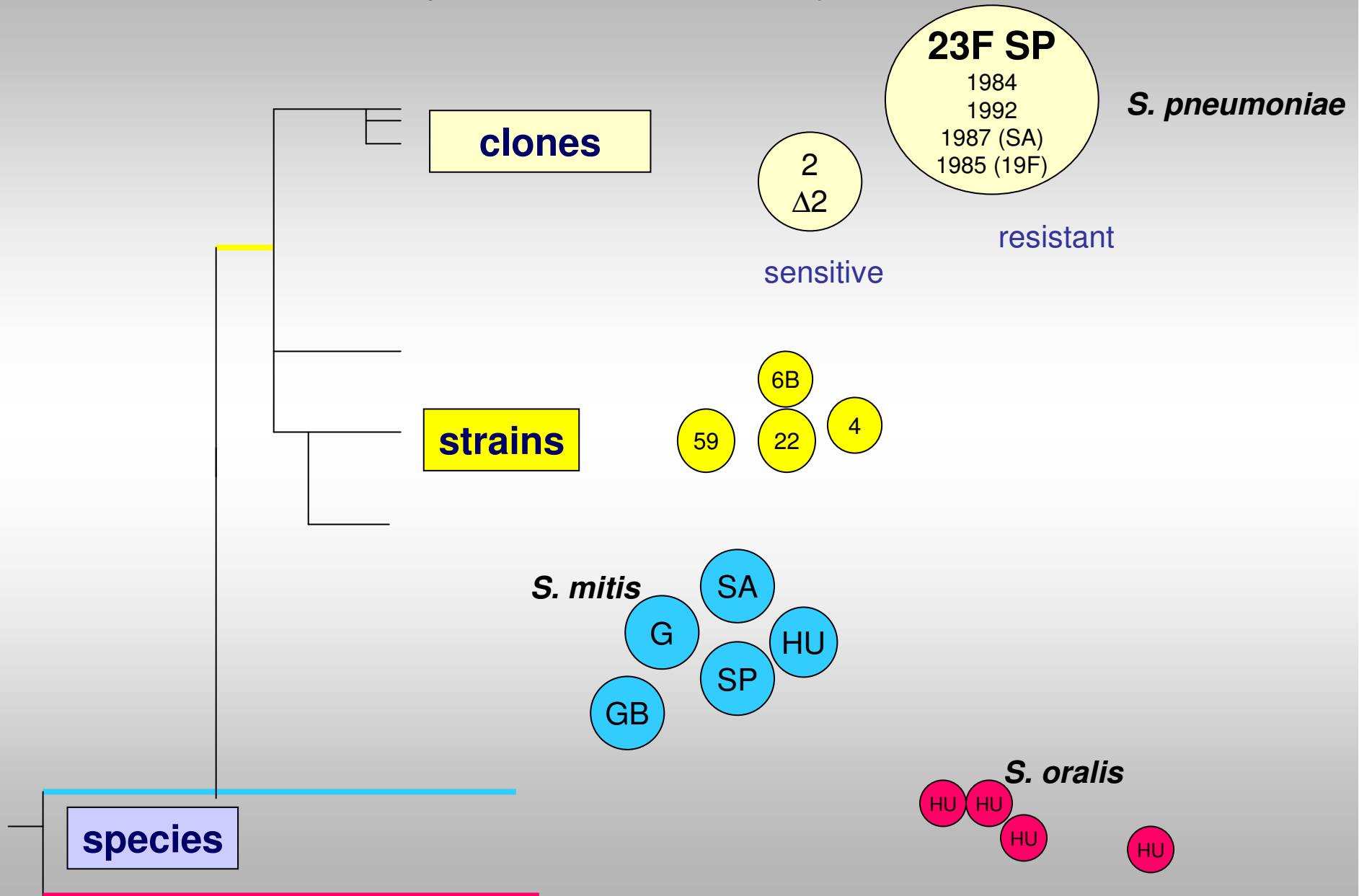
Streptococcus pneumoniae

pathogen

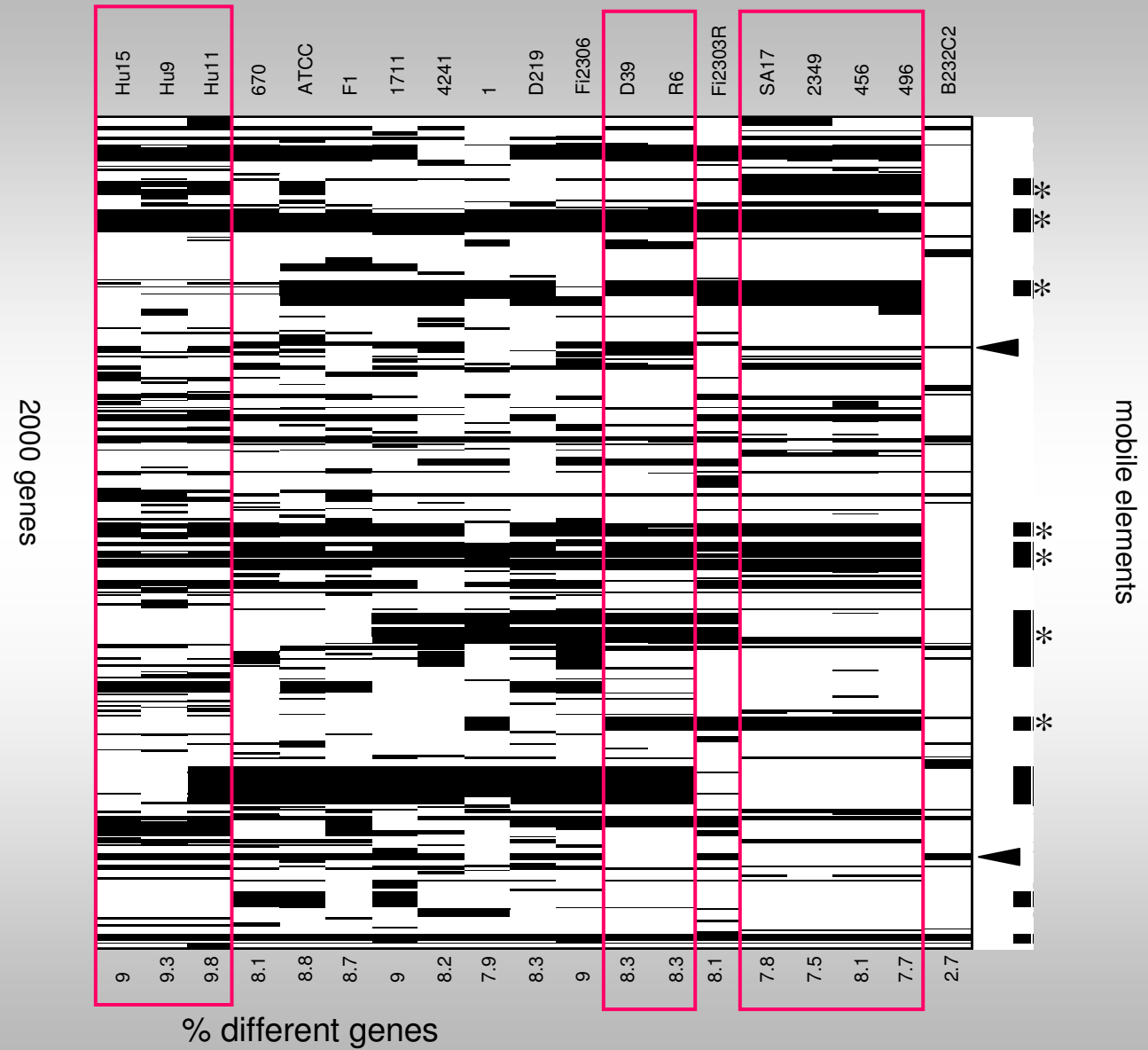
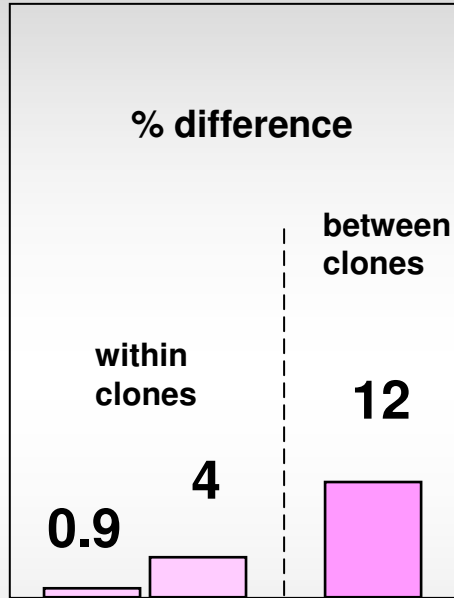
antibiotic resistance determinants



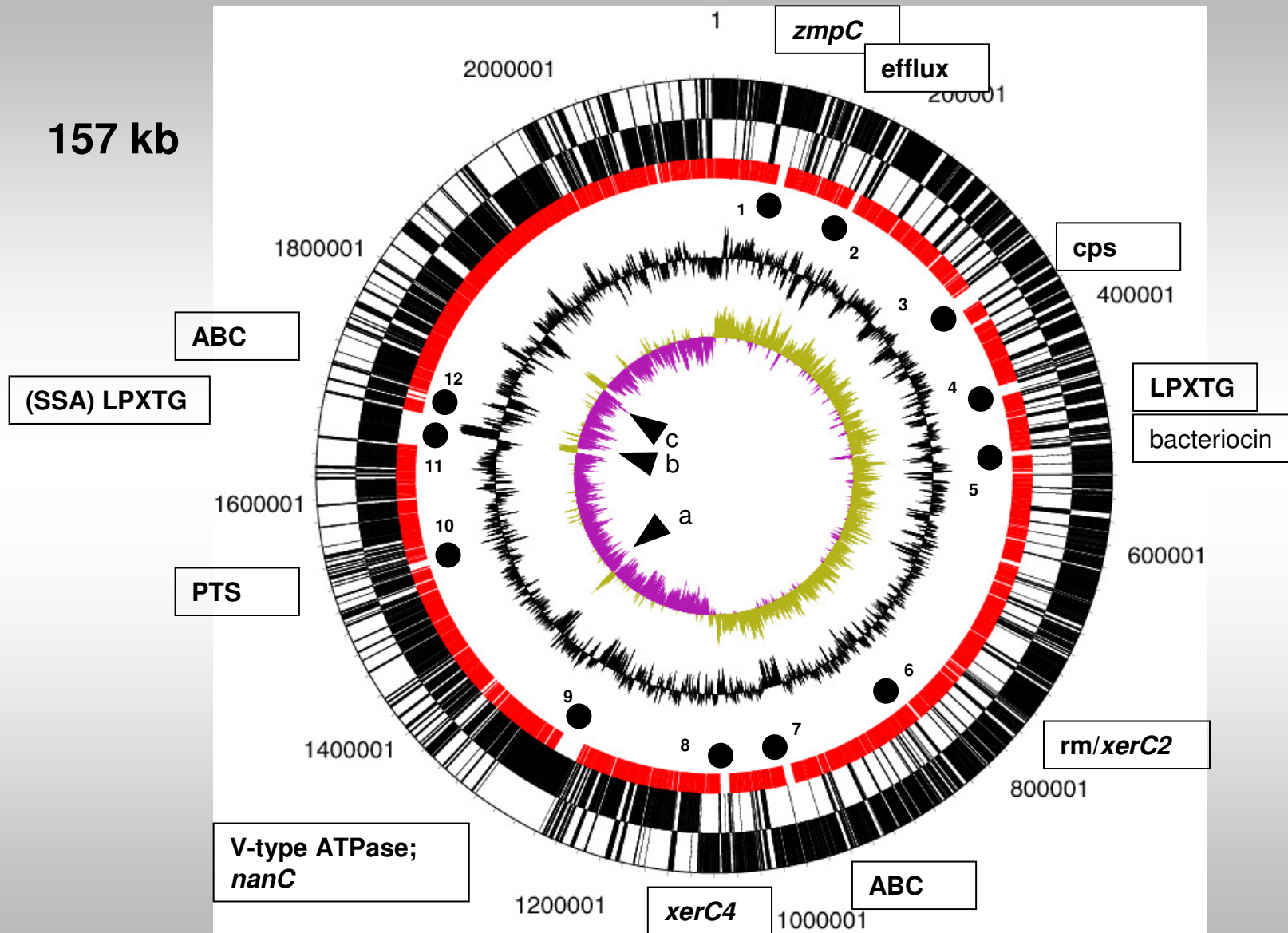
Comparative Genomic Analysis



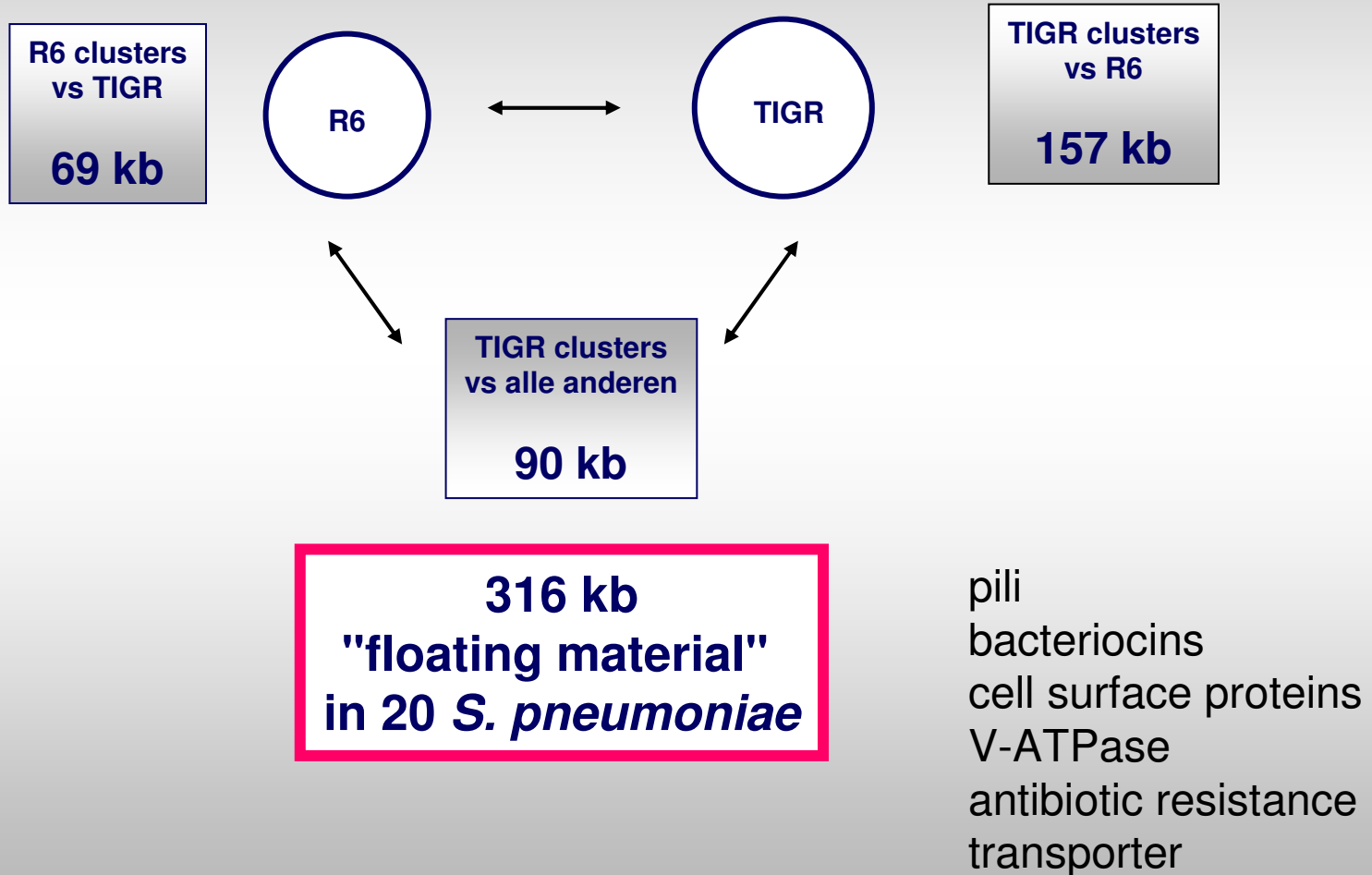
Genomic Comparison of *Streptococcus pneumoniae*



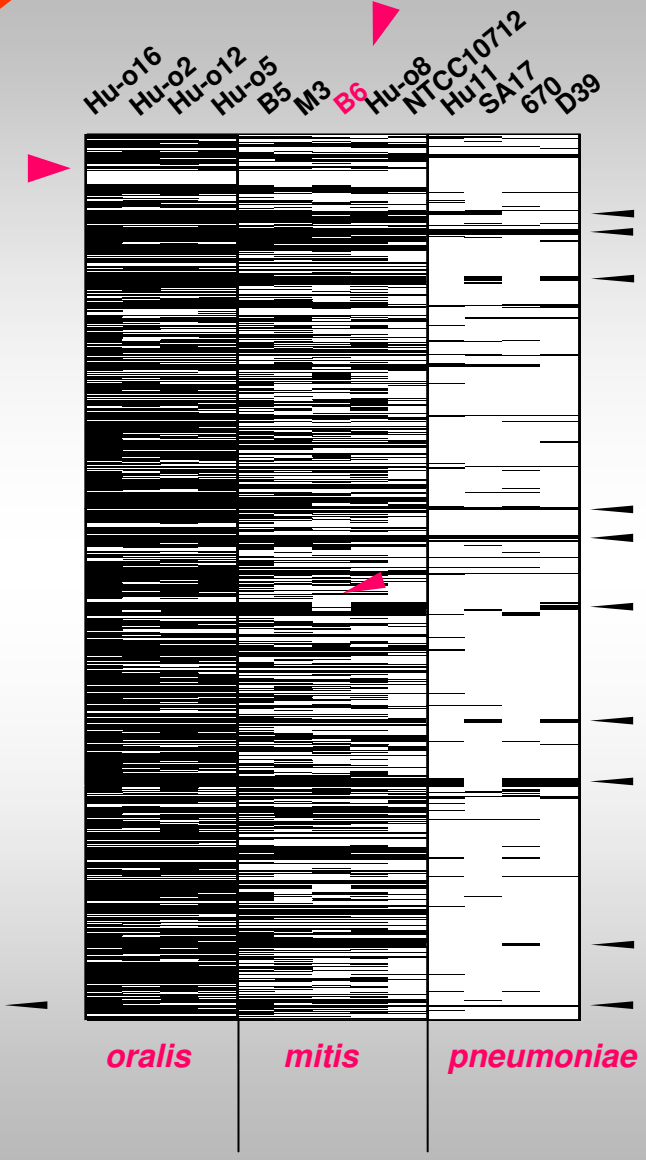
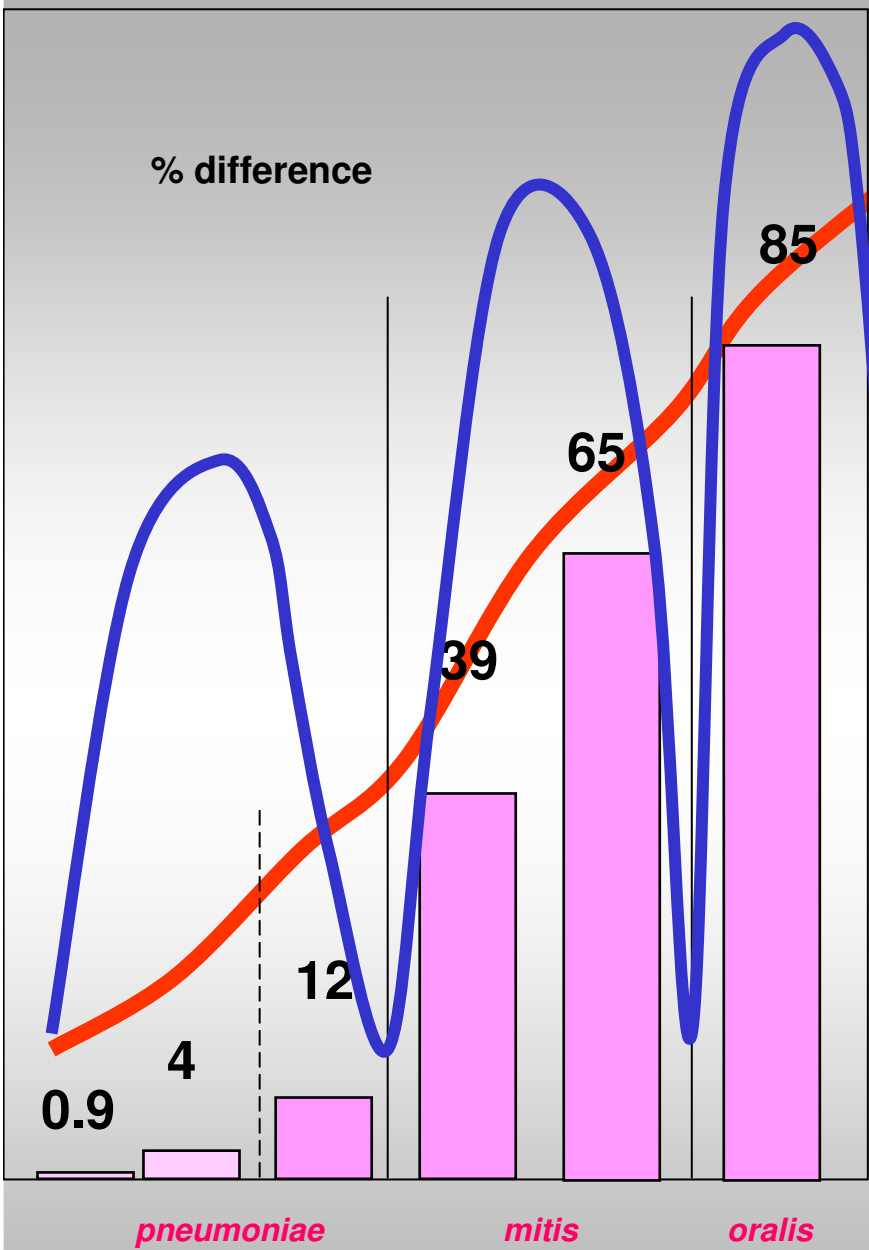
TIGR specific clusters versus R6



Comparison of 20 *S. pneumoniae* strains (TIGR array)



16 (partial) genomes: 1.550 kb core genome (Hiller et. al., 2007. J. Bacteriol.)



MLST analysis of Streptococcus sp.

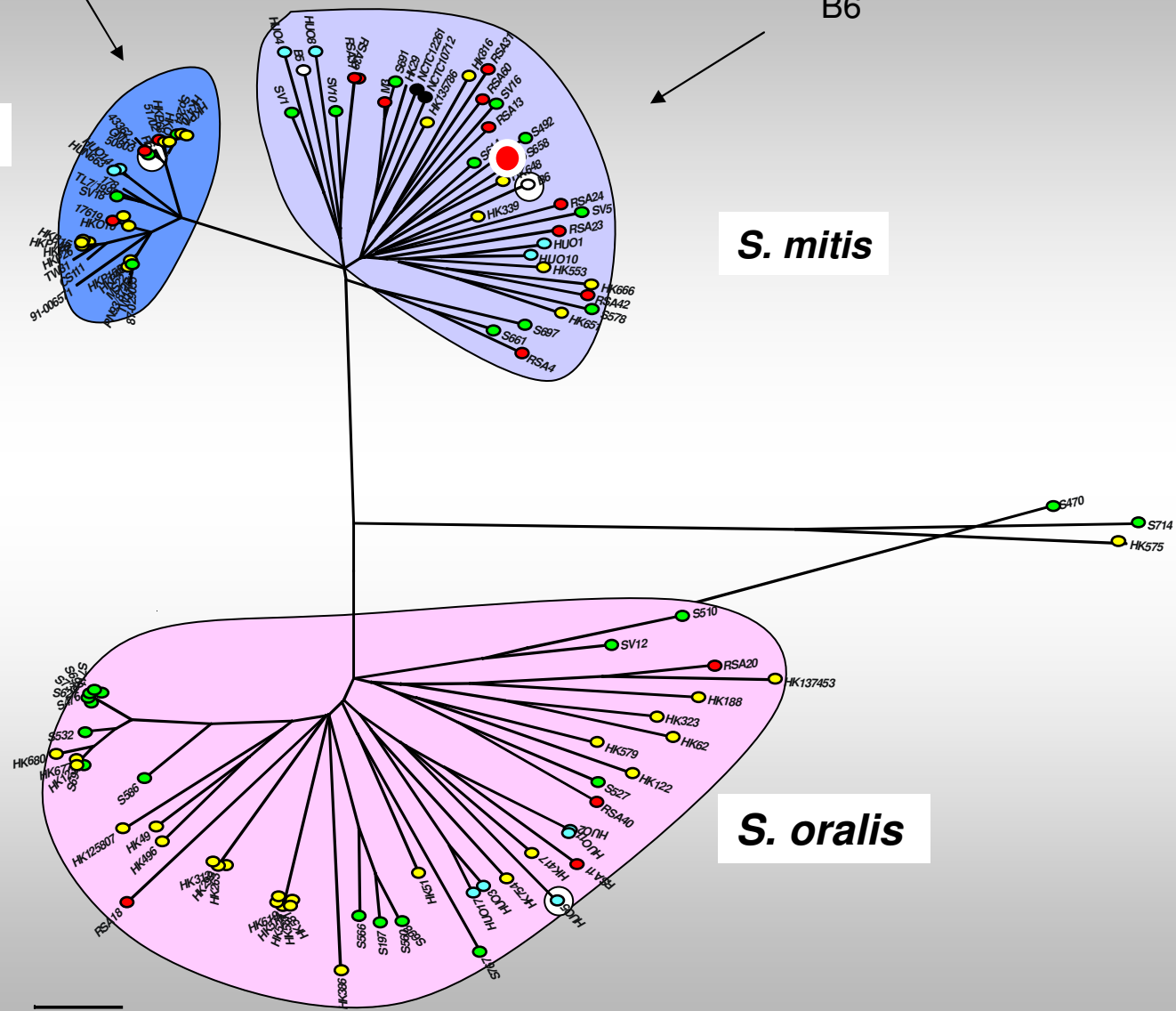
S. pneumoniae

R6

B6

S. mitis

S. oralis



0.01

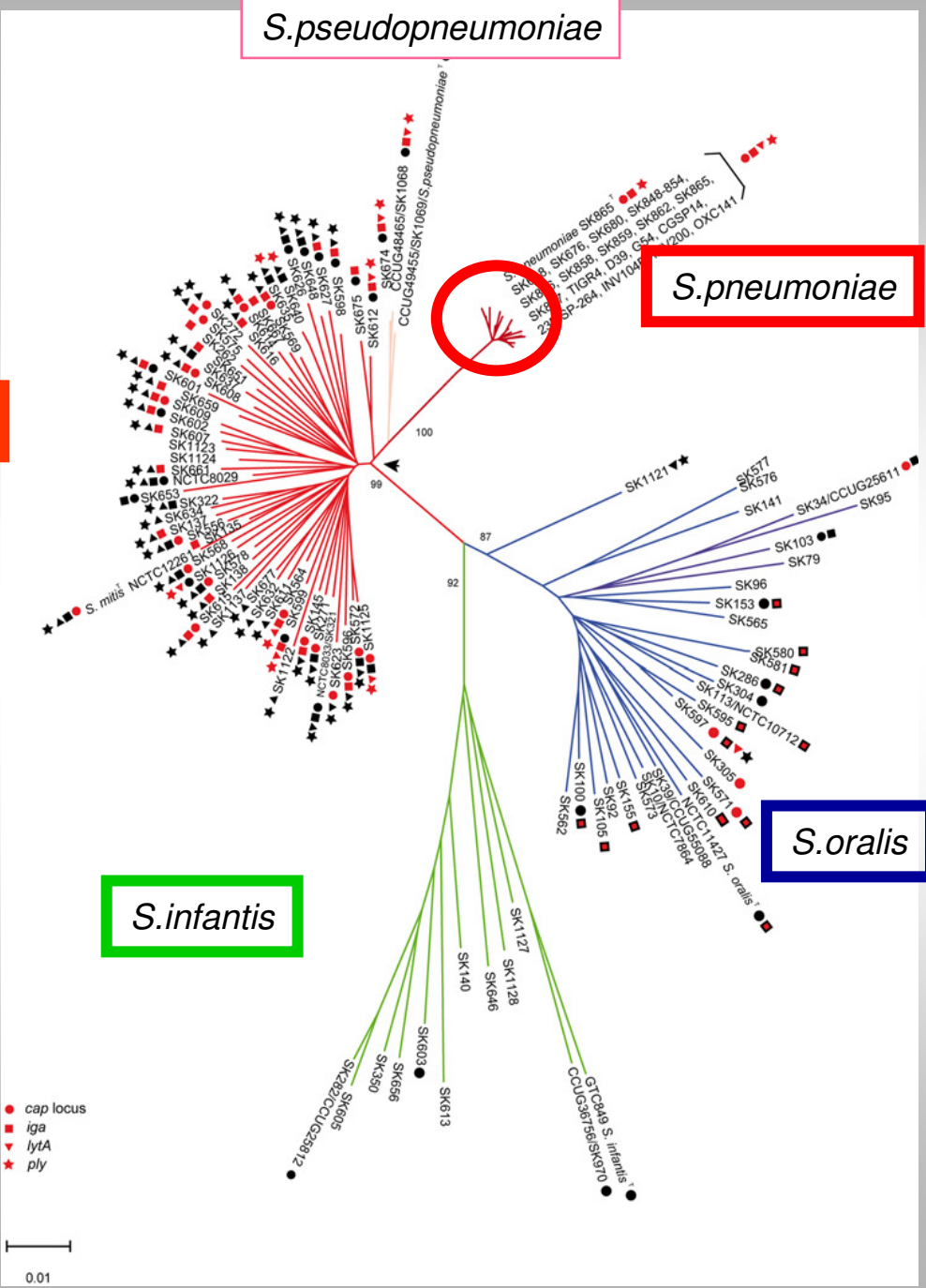
S. mitis

S. pseudopneumoniae

S. pneumoniae

S. oralis

S. infantis



tree based on
ddl, *gdh*, *rpoB*, and *sodA*

***Streptococcus mitis* B6:**
A high level beta-lactam and multiple antibiotic resistant strain

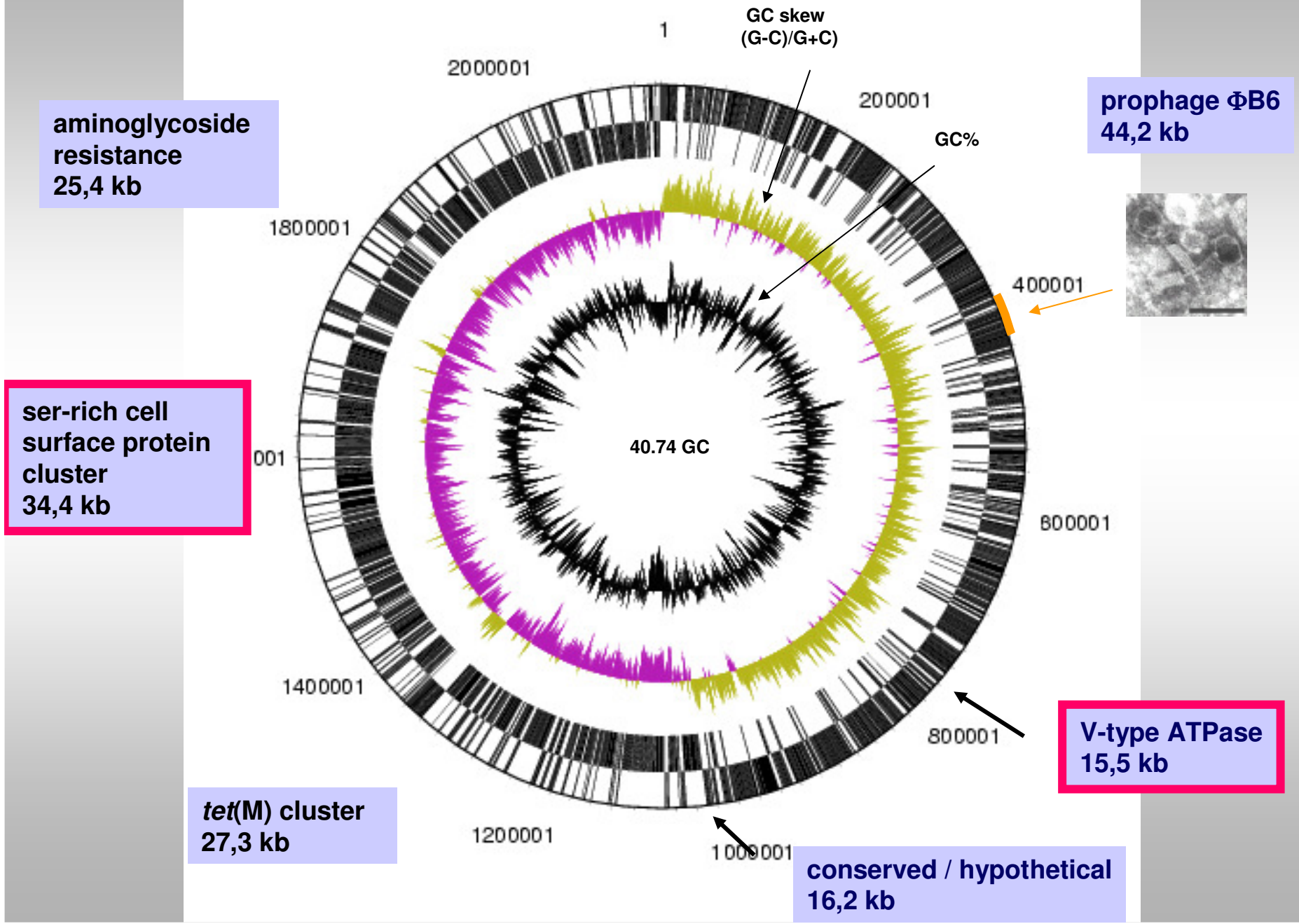
In vitro antibiotic susceptibilities of *Streptococcus mitis* B6

MIC ($\mu\text{g/ml}$)

Penicillin G	>32	Erythromycin	0.19
Cefotaxime	>32	Clindamycin	0.125
Piperacillin	>256	Gentamicin	>1024
Cephalothin	>256	Tobramycin	>256
Cefepime	>32	RP59500	1.5
Cepodoxime	>256	Sparfloxacin	0.75
Cefpirome	64	Tetracyclin	r
Cefuroxime	>256	Chloramphenicol	s
Ceftazidime	>256		
Imipenem	2.0		
Meropenem	2		

163 kb in six clusters

Streptococcus mitis B6



aminoglycoside resistance
25,4 kb

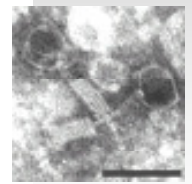
ser-rich cell surface protein cluster
34,4 kb

tet(M) cluster
27,3 kb

conserved / hypothetical
16,2 kb

V-type ATPase
15,5 kb

prophage Φ B6
44,2 kb



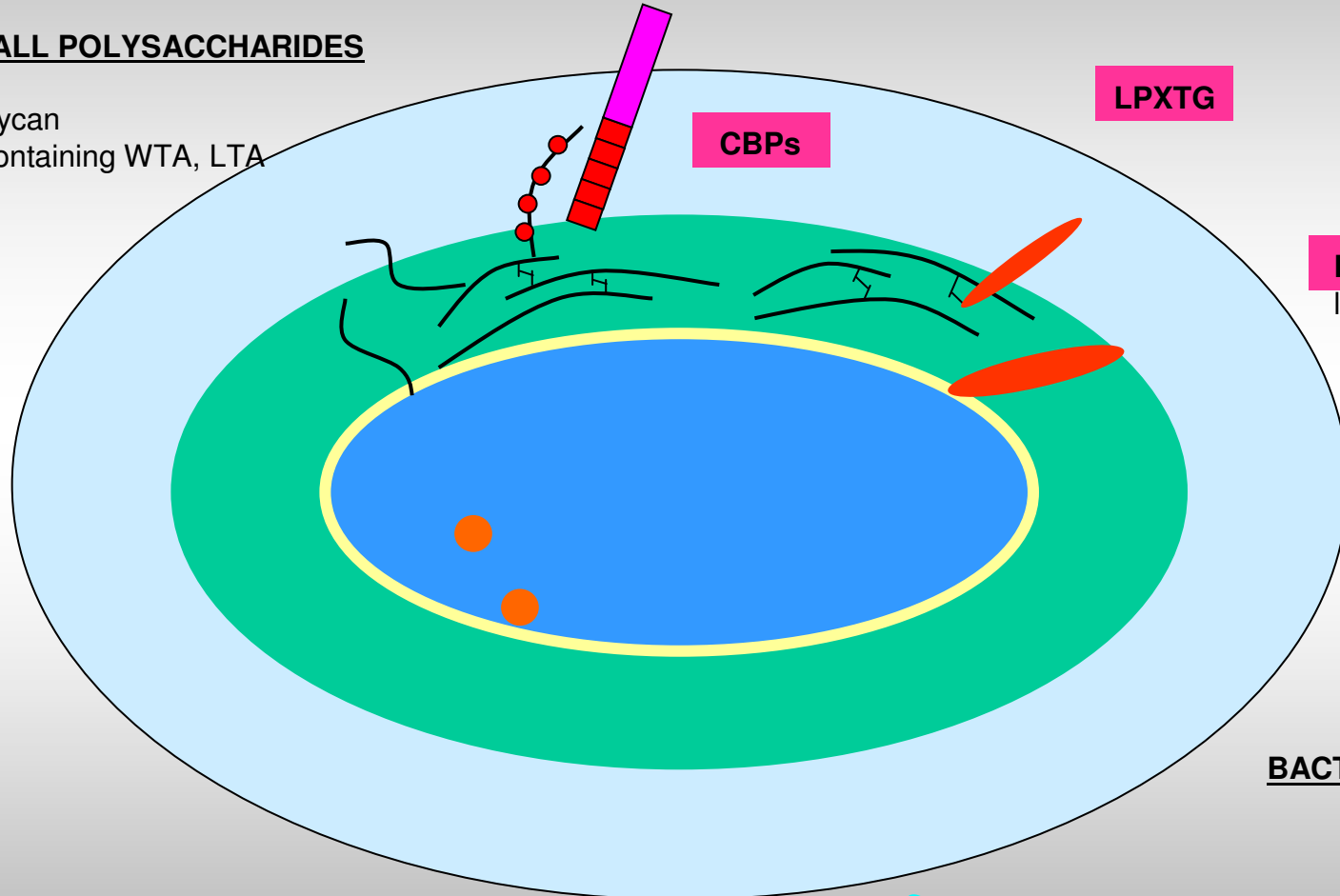
Streptococcus pneumoniae virulence factors

Phase variation (blood versus mucosa)

cell wall associated proteins

CELL WALL POLYSACCHARIDES

capsule
peptidoglycan
choline containing WTA, LTA



LXXC
lipoproteins

LPXTG

CBPs

BACTERIOCINS

PROTEINS RELEASED UPON AUTOLYSIS

pneumolysin
autolysin

SECRETED PROTEINS

neuraminidase
hyaluronidase



Dept. of Microbiology
Reinhold Brückner
Dalia Denapaite
Bernhard Henrich
Patrick Maurer
Yvonne Schähle
Abderrahim Madhour
Ilka Zerfaß
Regine Hakenbeck

Nano-Bio-Center KL
Peter Reichmann
Michael Nuhn
Sonja Schröck

BMBF
DFG
EU
Helmholtz Stiftung
Innovation Rh-Pf.
Schwerpunkt TU KL

communication is evolution is communication is evolution is communication is evolution is communication