Salmonella Infantis persistence in U.S. poultry and analysis of the plasmid carrying the CTX-M-65 ESBL GENE

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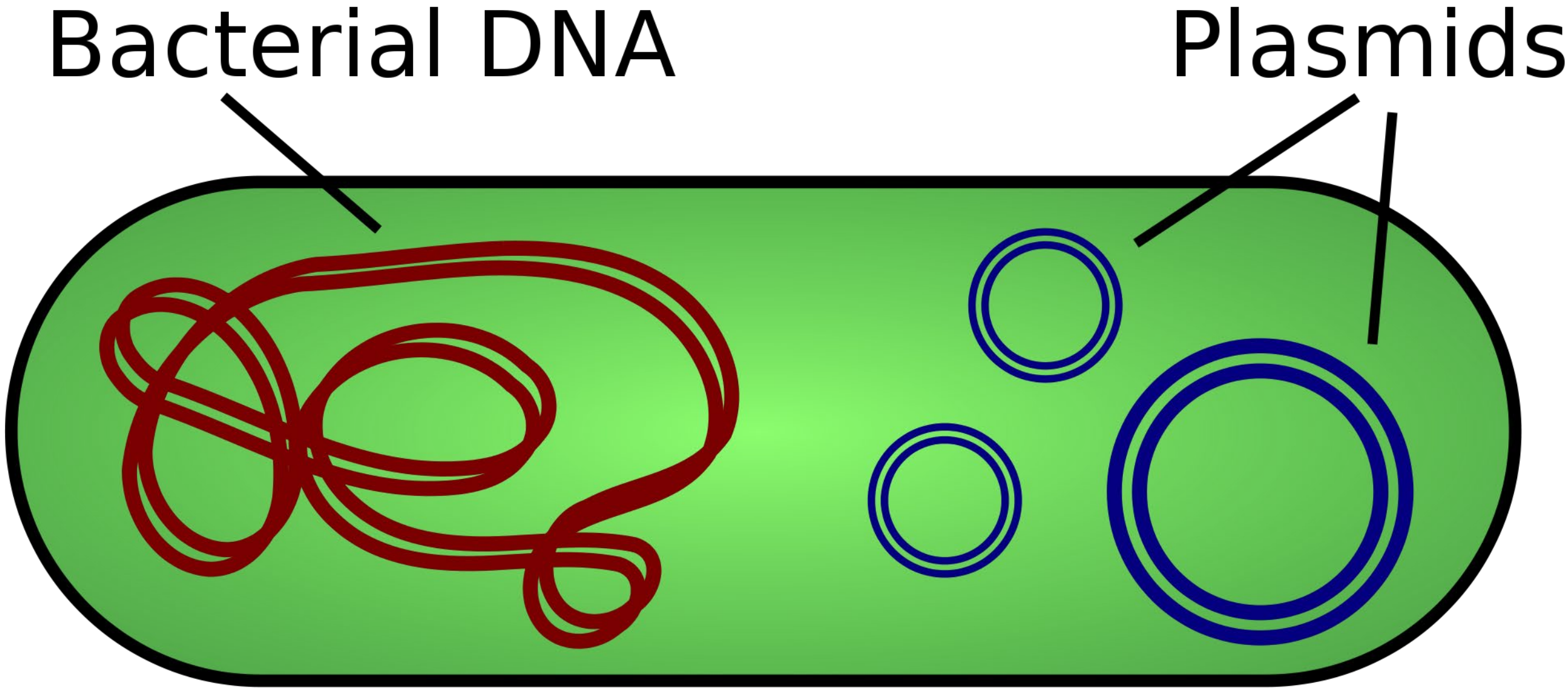
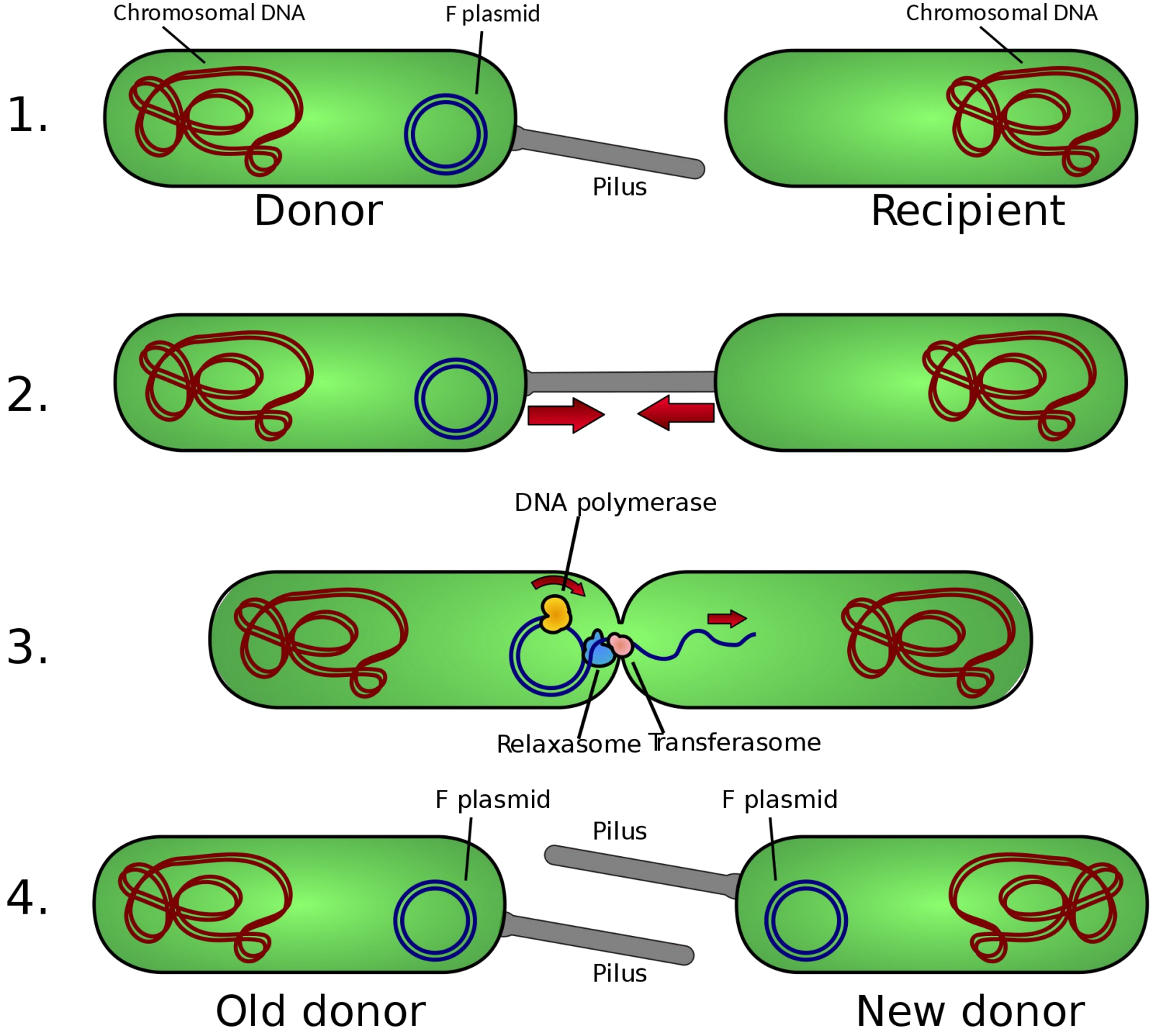
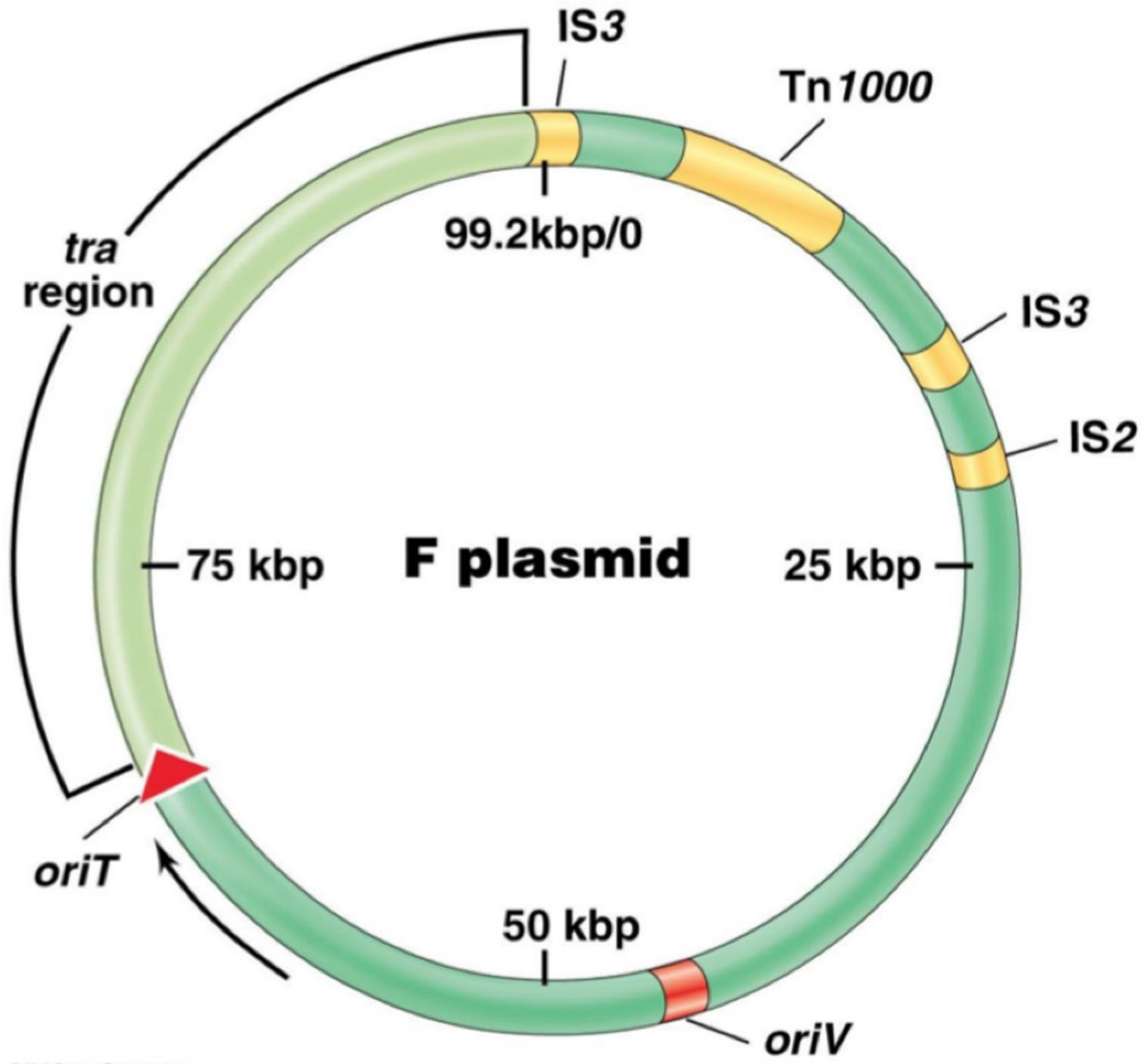
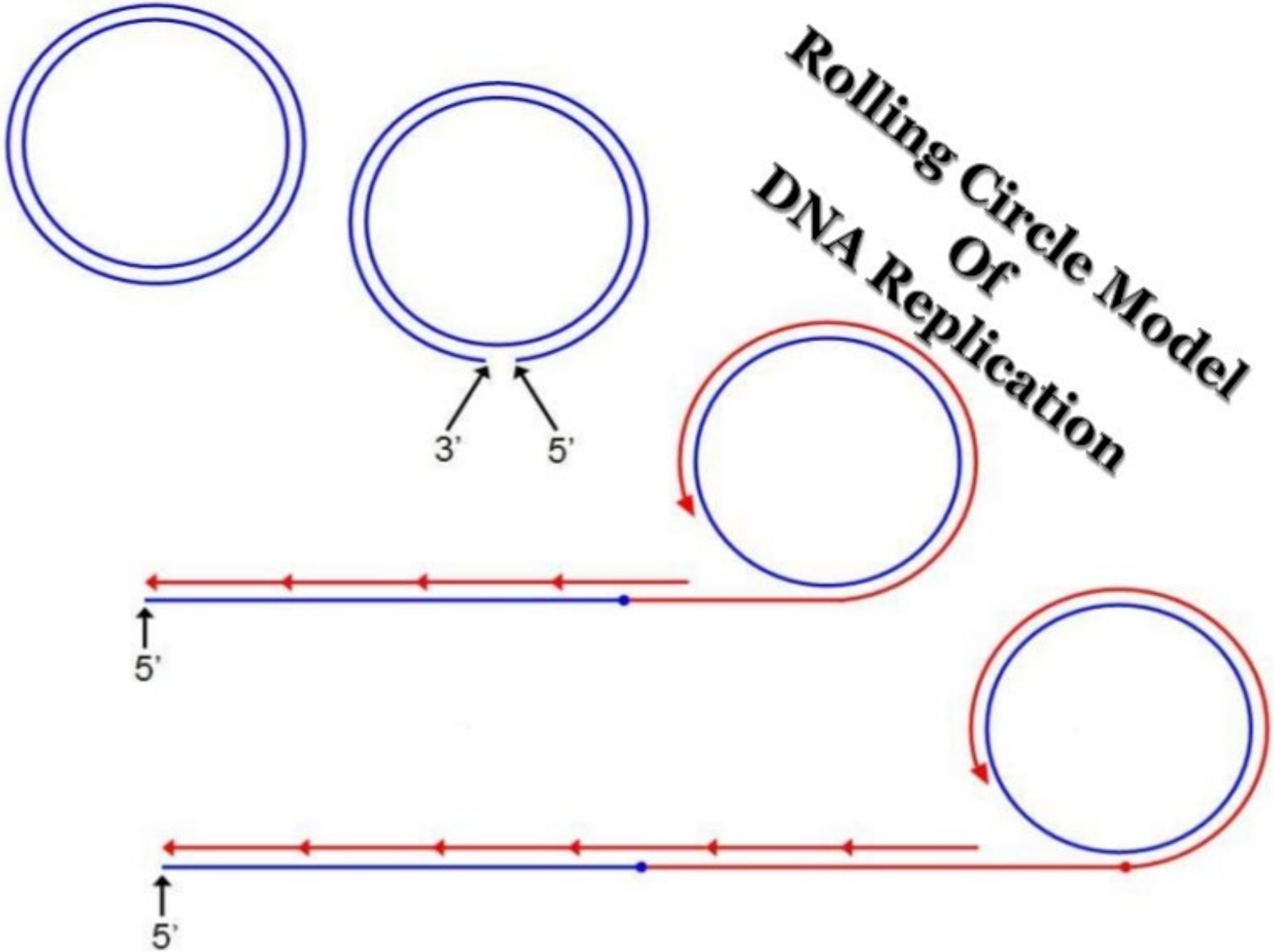
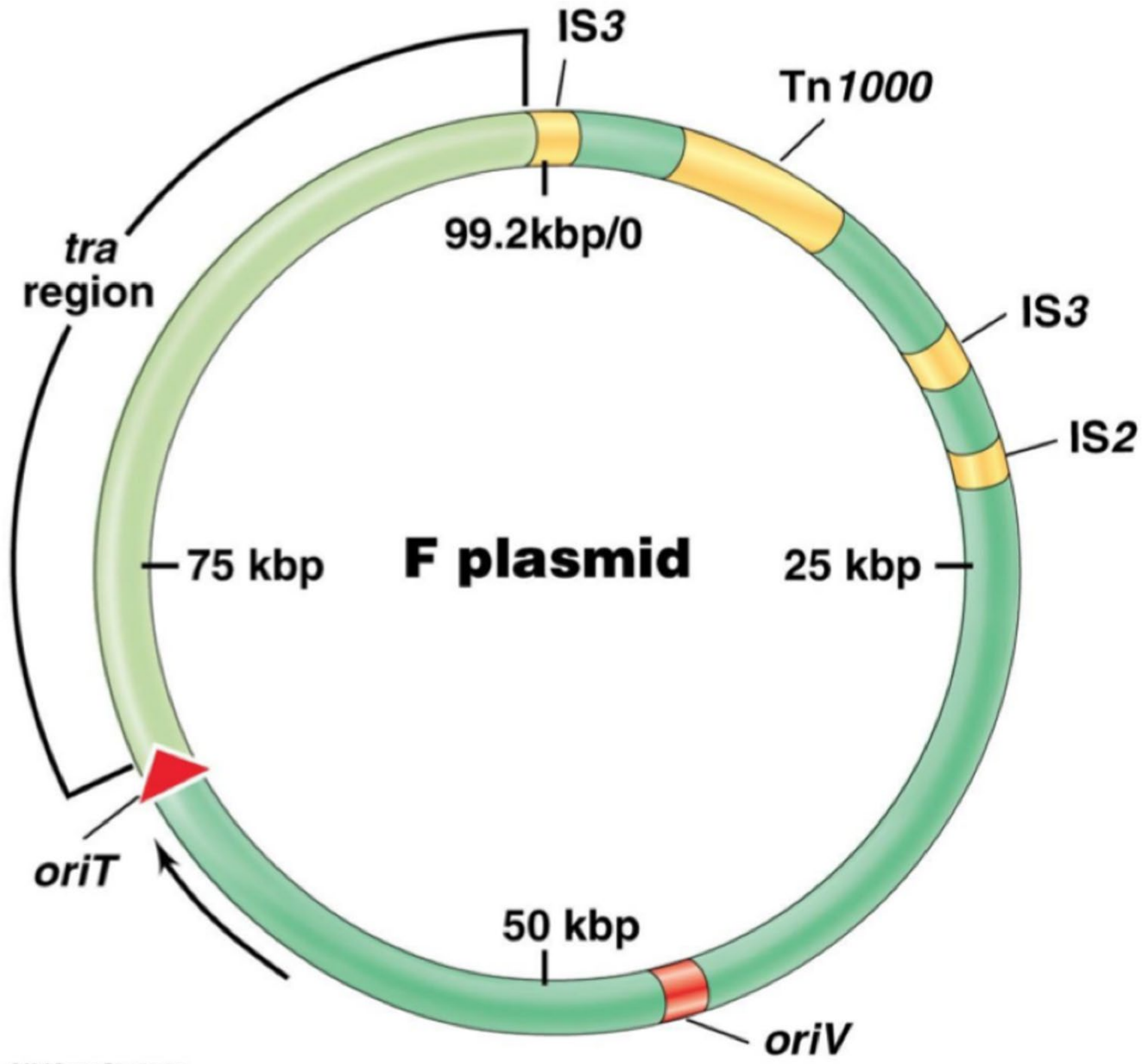

Bacterial DNA
Plasmids

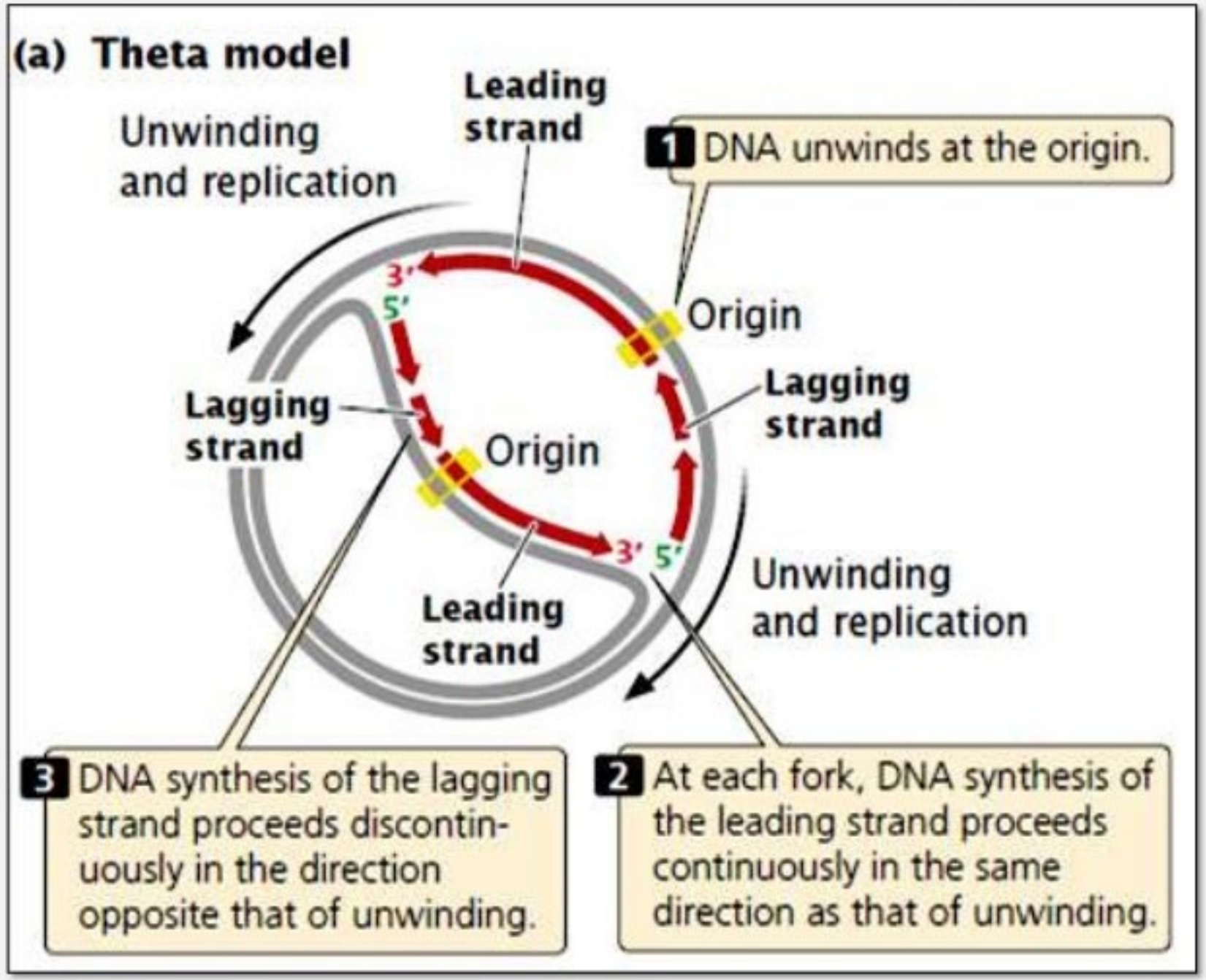

1.
Chromosomal DNA
F plasmid
Chromosomal DNA
Pilus
Donor
Recipient
2.
3.
DNA polymerase
Relaxasome
Transferasome
4.
F plasmid
Pilus
F plasmid
Pilus
Old donor
New donor



Rolling Circle Model Of DNA Replication

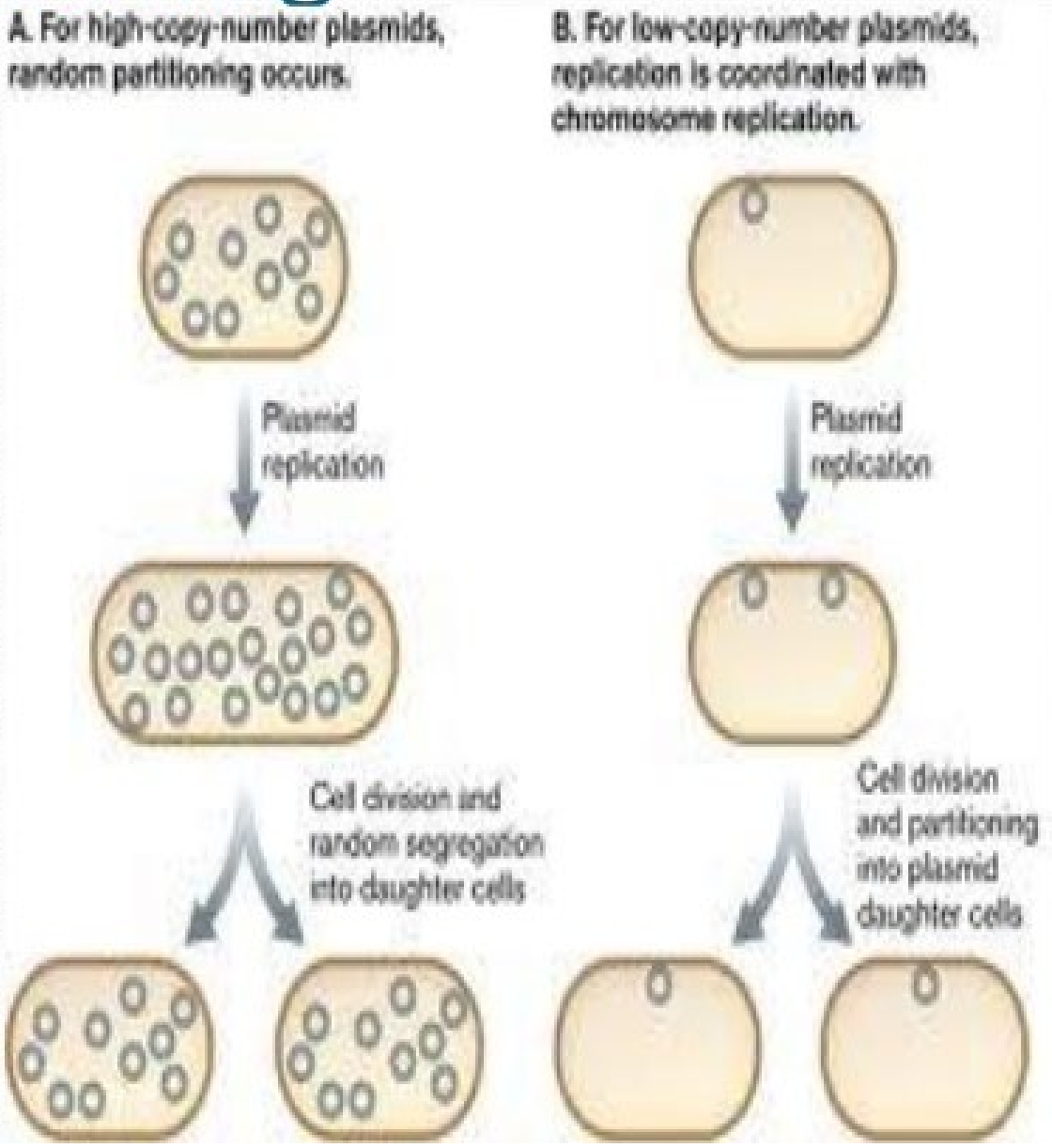





(a) Theta model
Unwinding and replication
Leading strand
1 DNA unwinds at the origin.
3′
5′
Origin
Lagging strand
Lagging strand
Origin
3′
5′
Leading strand
Unwinding and replication
3 DNA synthesis of the lagging strand proceeds discontinuously in the direction opposite that of unwinding.
2 At each fork, DNA synthesis of the leading strand proceeds continuously in the same direction as that of unwinding.

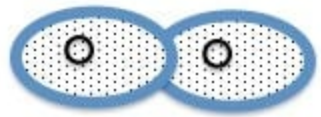
Plasmid partitioning

- High copy no. plasmid do not have any mechanism of partitioning .
- Low copy no. plasmids must have a mechanism to ensure their proper partitioning.



Cell cycle with 1 plasmid

Cell grows and plasmid replicates



Cell division occurs

Each daughter cell has 1 copy of same plasmid

Cell cycle with 2 incompatible plasmids

Cell grows but plasmids do not replicate as 2 origins are already present

Cell division occurs

Incompatible plasmids have been distributed to different daughter cells

USDA Agricultural Research Service
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BEAR
Bacterial Epidemiology and Antimicrobial Resistance

Salmonella Infantis persistence in U.S. poultry and analysis of the plasmid carrying the CTX-M-65 ESBL GENE

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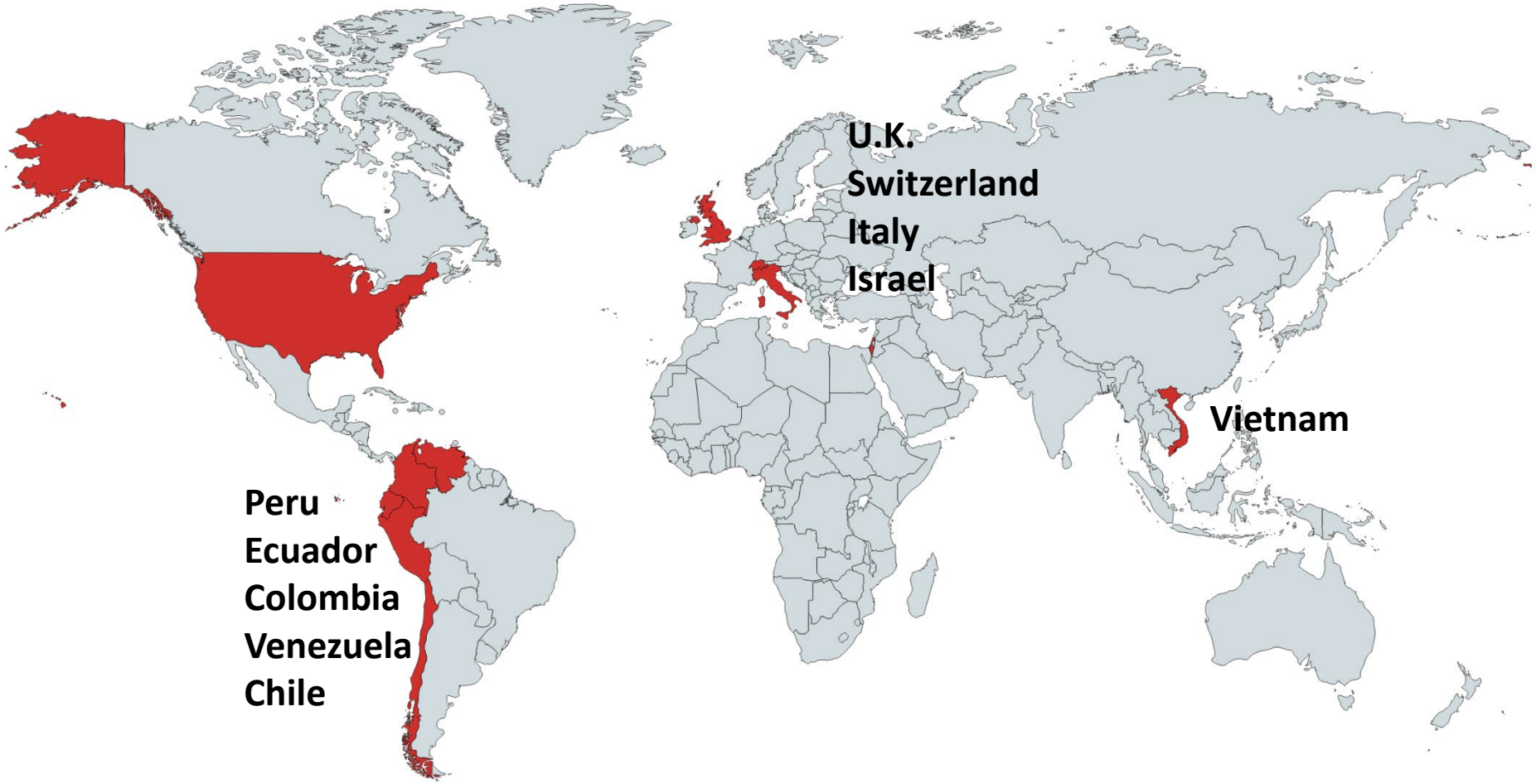
Analysis of *Salmonella* Infantis and the pESI plasmid

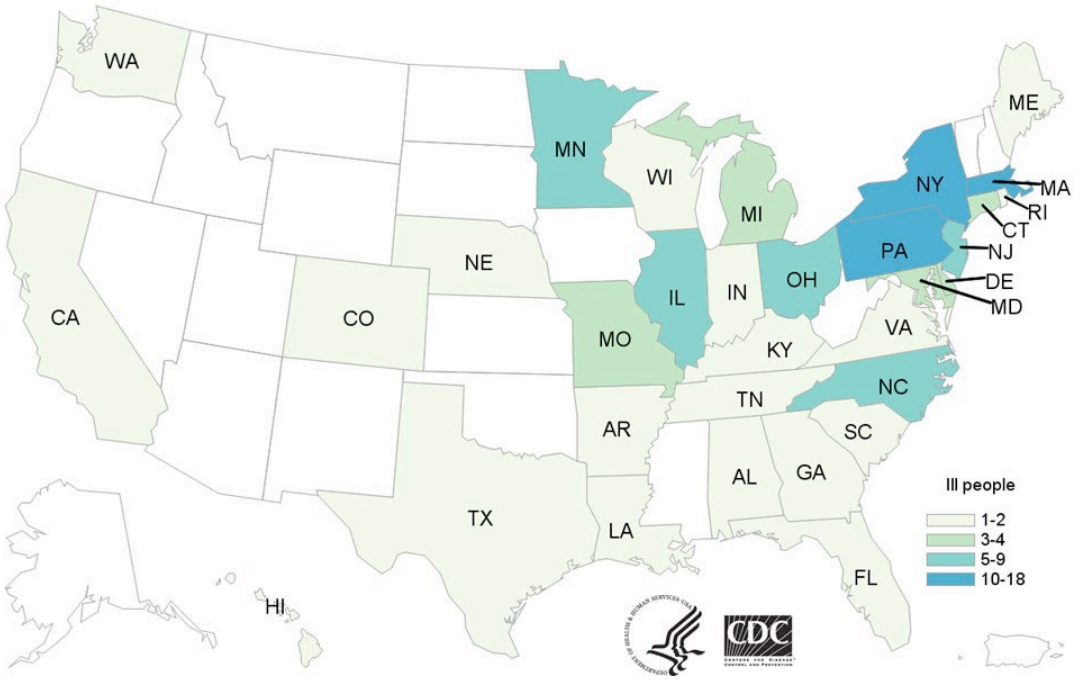
- Outbreak strain associated with U.S. poultry and human infections
- Ongoing problem
- The pESI may encode MDR as well as a CTX-M-65 Extended Spectrum Beta-Lactamase (ESBL)
- The pESI also encodes several fitness genes that may explain why it persists

Known Geographic Range

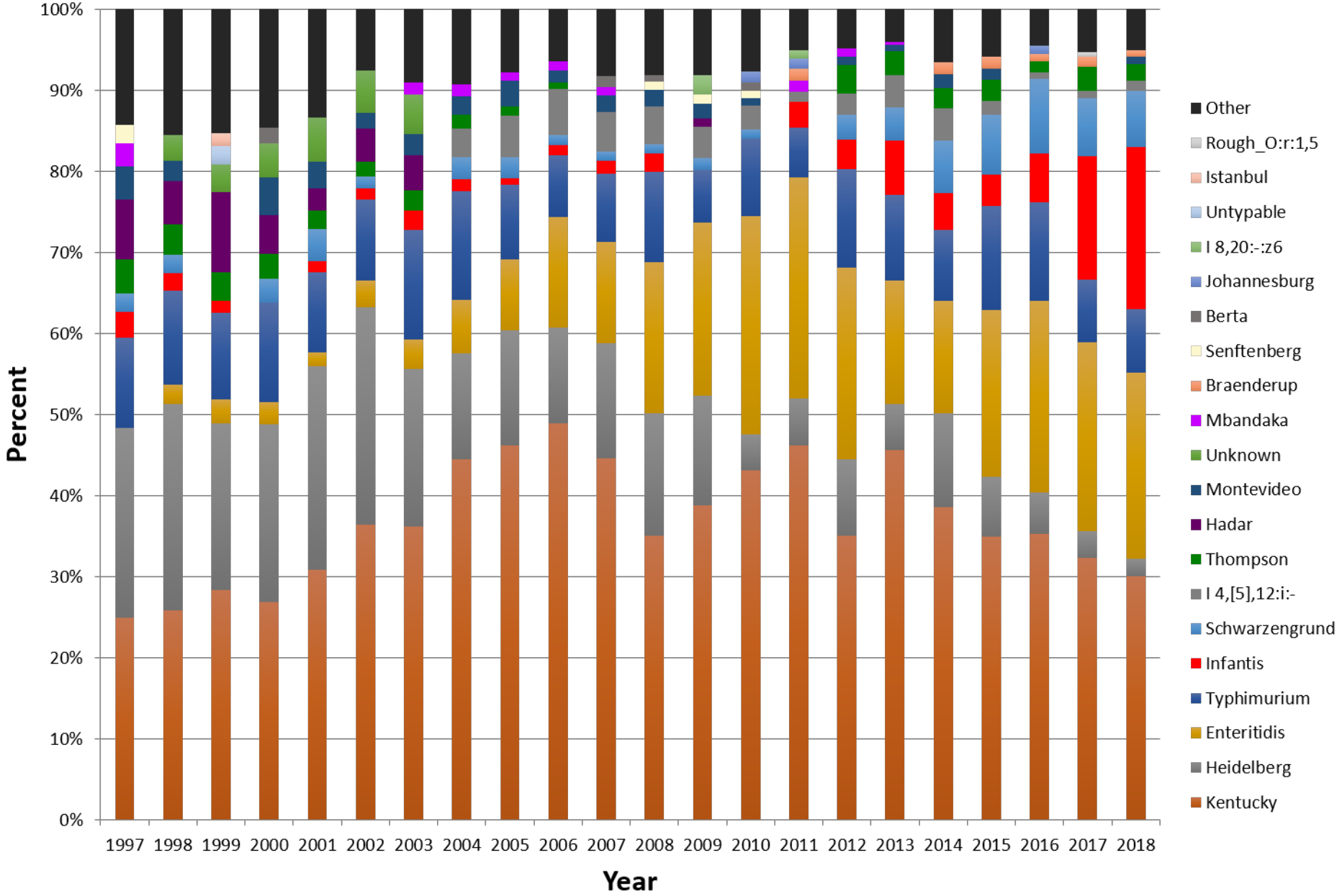


Salmonella Infantis Outbreak

- 1/8/2018 - 1/27/2019
- 129 cases
- Associated with raw chicken

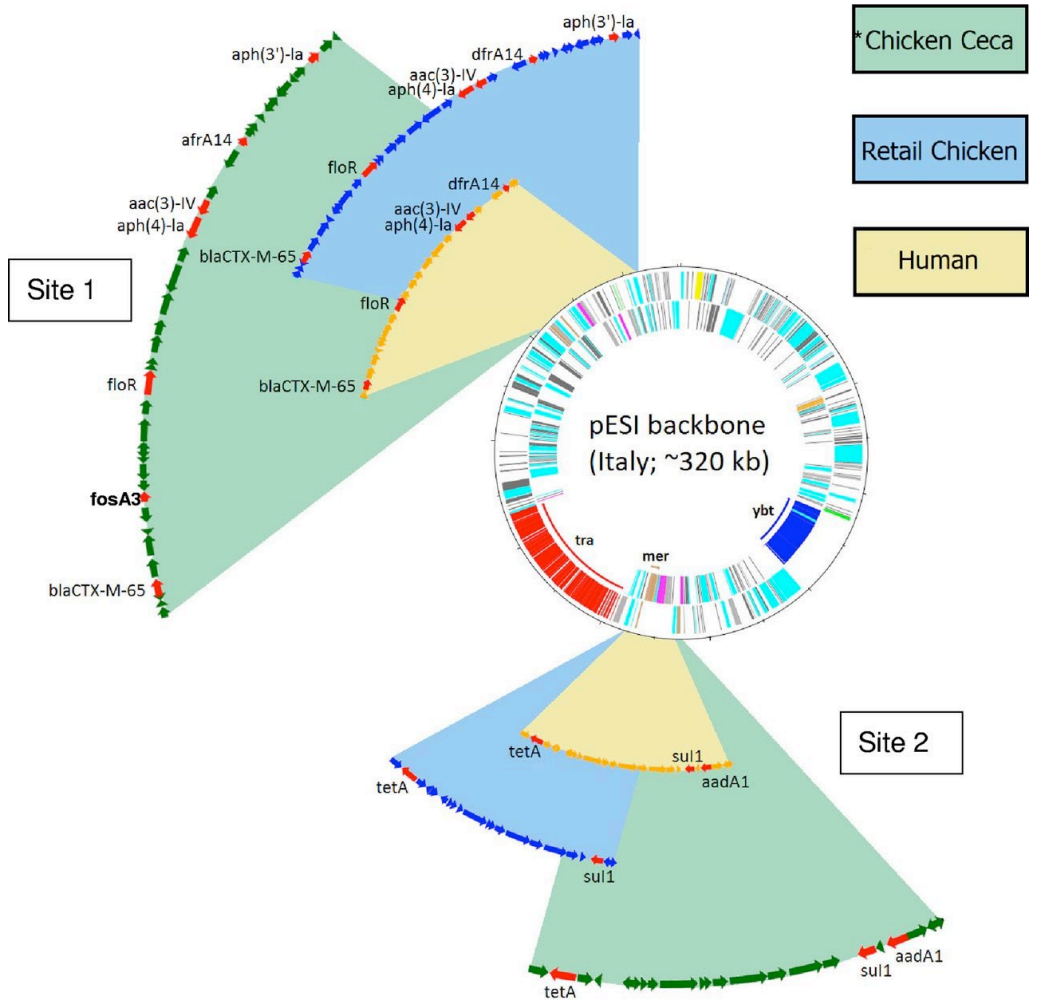


Percent of top 10 *Salmonella* serotypes isolated from chickens per year (Infantis are the bright red portion of each bar)

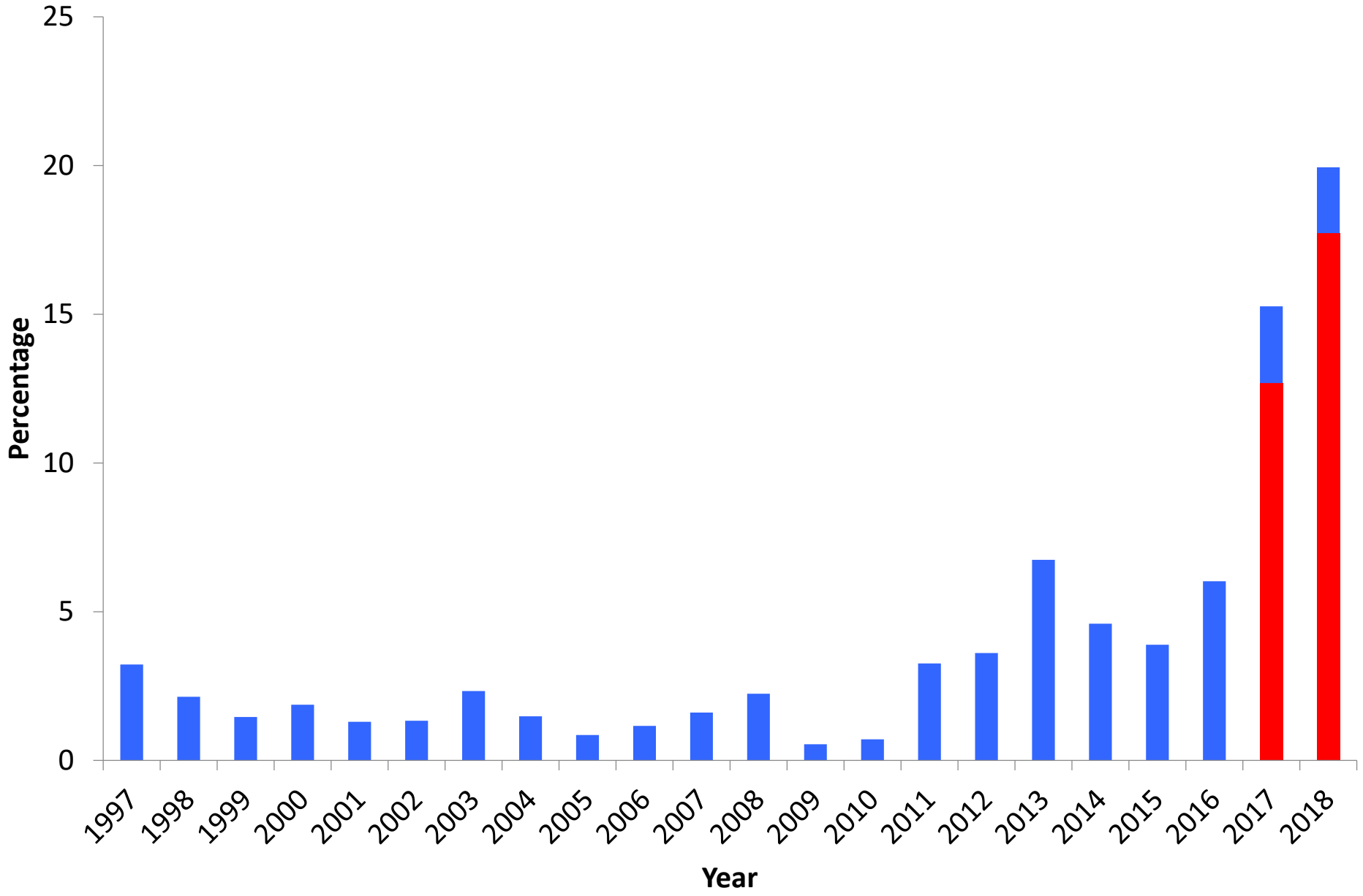


pESI plasmid

- Plasmids are circular DNA that carry “extra genes”
- Plasmids can be transferred between bacteria through conjugation during mating
- pESI is large ~300 kb
- Encodes over 300 genes
- Can contain *bla*$_{\text{CTX-M-65}}$
- Multi-Drug Resistant
- Metal resistance
- Iron transport system
- Fimbriae for attaching to human and chicken cells



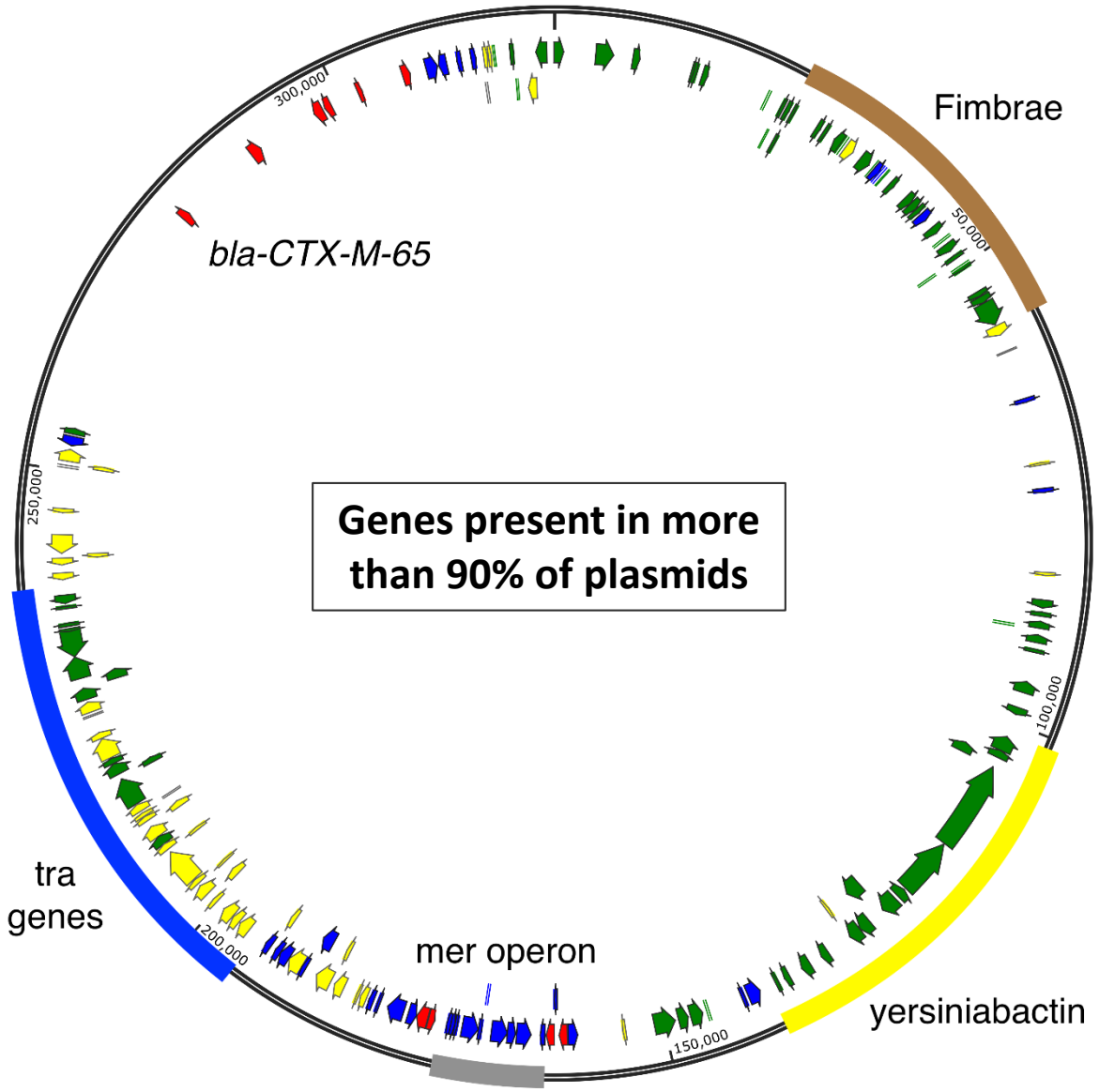
Tate et al 2017


Percentage of *Salmonella* isolated from poultry products that are serotype Infantis (red part = with the pESI plasmid)
Percentage
25
20
15
10
5
0
1997
1998
1999
2000
2001
2002
2003
2004
2005
2006
2007
2008
2009
2010
2011
2012
2013
2014
2015
2016
2017
2018
Year

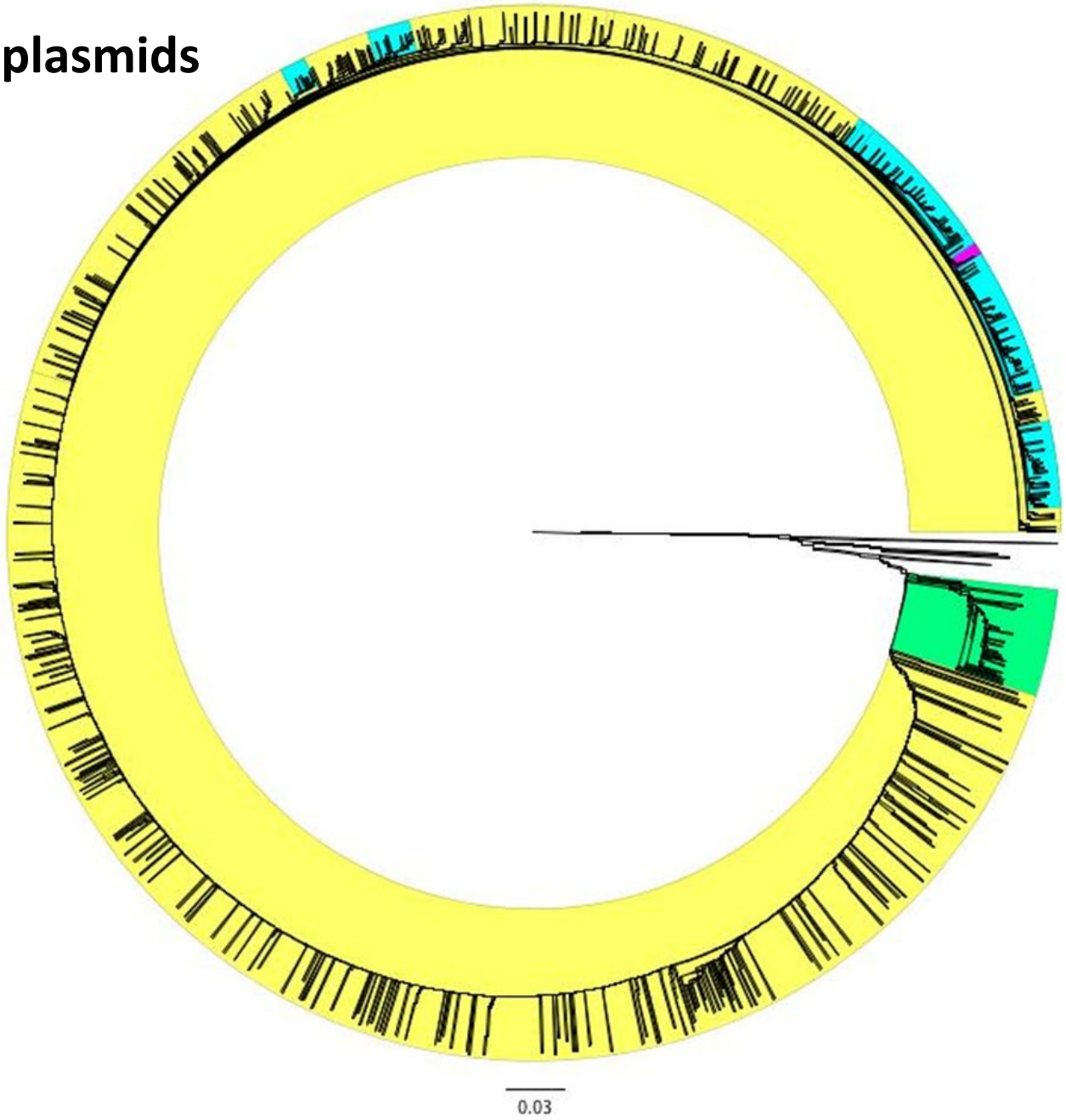
Incidence of the pESI plasmid in *Salmonella* from U.S. Chicken (HACCP)

- **2017: 15% of the total isolates reported in chicken were serotype Infantis (n=314/2059); 83% of Infantis isolates reported contained the plasmid (n=261)**
- **2018: 20% of the total isolates reported in chicken were serotype Infantis (n=389/1957); 89% of Infantis isolates reported contained the plasmid (n=345)**

Concensus of pESI genes found in our study of 2,627 sequences from all sources



Dendrogram of pESI plasmids (n=2627)



Genes of interest on the pESI plasmid:

- **Antibiotic resistance genes are present in between 90% and 50% of isolates**
- **Heavy metals resistance genes including mercury and arsenic**
- **Fimbriae: this strain attaches to human and chicken cells better than other *Salmonella* Infantis strains without fimbriae**
- **Siderophore system from *Yersinia pestis* (**Yersiniabactin**): this strain could be better at acquiring iron**

Outcome of Salmonella *Infantis research*

- **Persistence may be due to the plasmid encoding fitness factors that give it an advantage in chickens or in chicken associated environments**
- **Research is ongoing to test if these fitness factors change the phenotypes of the host bacteria**
- **Development of possible interventions to eliminate *Salmonella* Infantis from U.S. poultry**

Acknowledgements

- **USDA-ARS, BEARRU**
  First row: Gabi Cho, Benny Barrett, Lari Hiott, Shaheen Humayoun, Charlene Jackson, Jonathan Frye, Sushim Gupta
  Second row: Ahn Nguyen, Tiffanie Woodley, Elizabeth McMillan
  Not pictured: Poonam Sharma, Hazem Ramadam, Martinique Edwards

- Kim Cook, Mark Berrang, Rick Meinersmann, Eileen Thacker
- Michael McClelland, University of California, Irvine
- Calvin Williams USDA, ARS
- John Johnston, Glenn Tillman, Jamie Wasilenko, and Mustafa Simmons with FSIS
- Collaborators at APHIS, CDC, FDA, and ARS
- Elizabeth Ottesen and Erin Lipp, UGA