

BIOCONTRACT

Is secretion of public goods the reason for the maintenance of mutualism between bacterial cells and conjugative plasmids?

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BIOCONTRACT

Plasmids and Bacterial cells

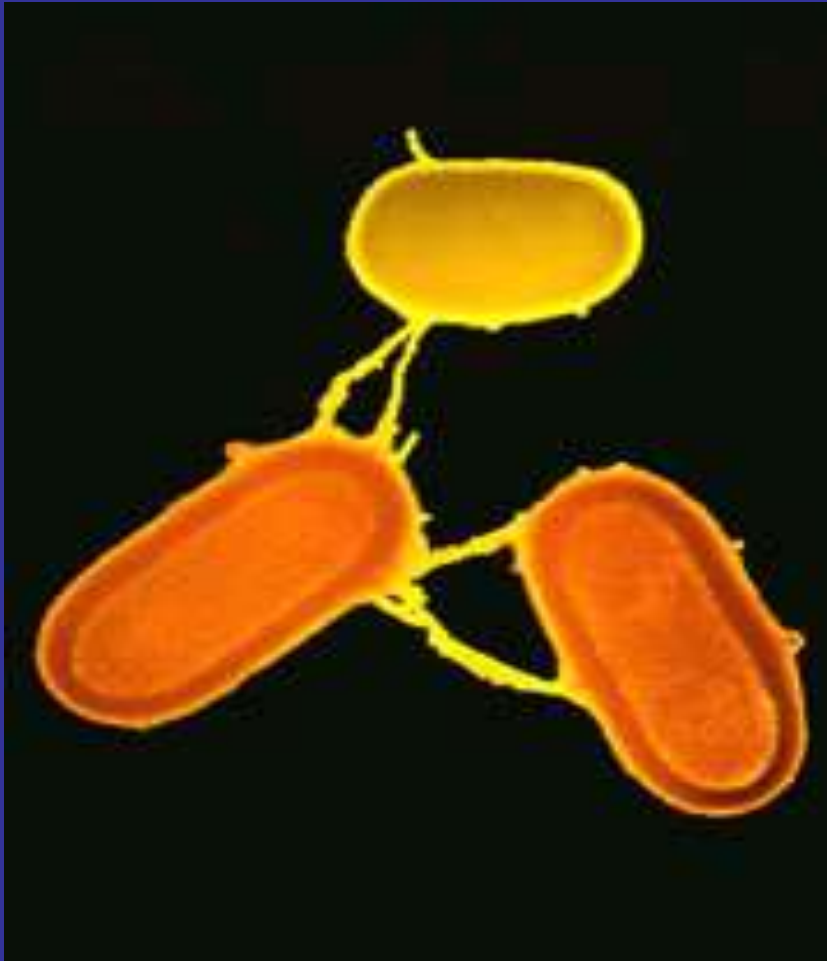
Conjugative Plasmids:

- These DNA molecules have the ability of transferring between bacterial cells.
- They are able of transfer within and between species.

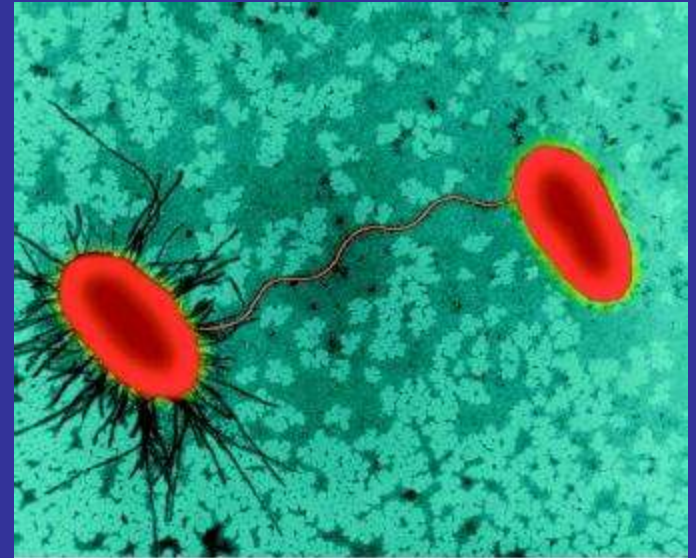
Questions for this project:

- Is this a mutualistic relationship?
- How is this mutualism maintained?
- Is there a *BIOCONTRACT* between bacterial cells and plasmids?

Plasmid Transfer

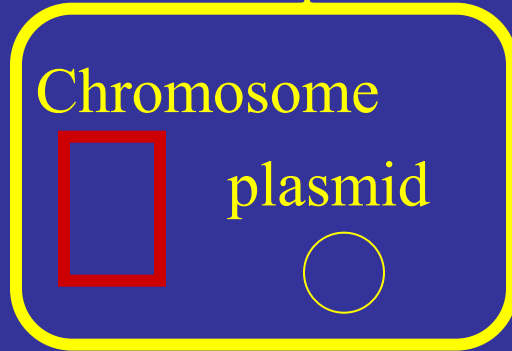


Picture from *Science* 1998



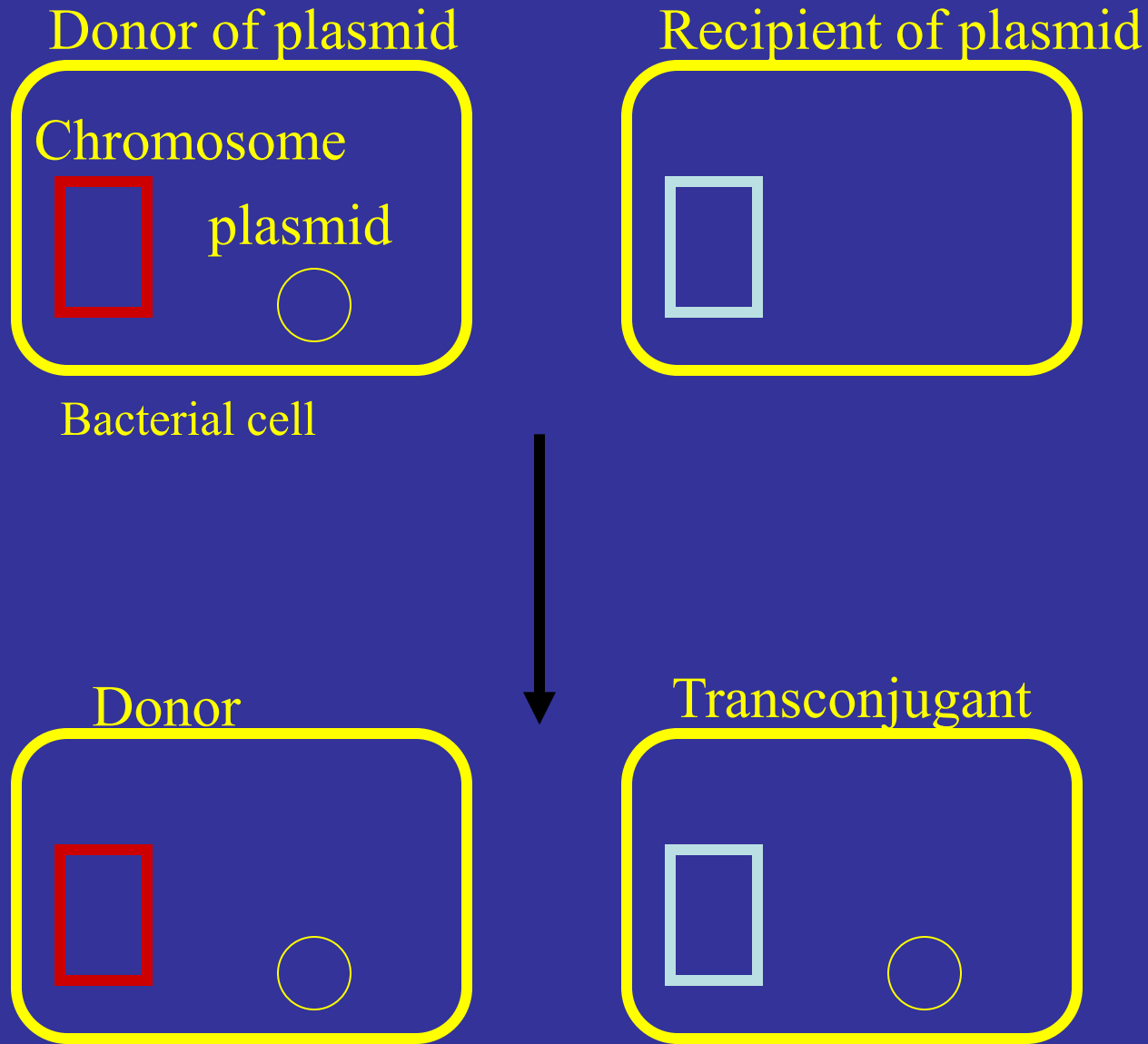
Picture from
Macmillan Science Library: Genetics.
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Donor of plasmid



Bacterial cell

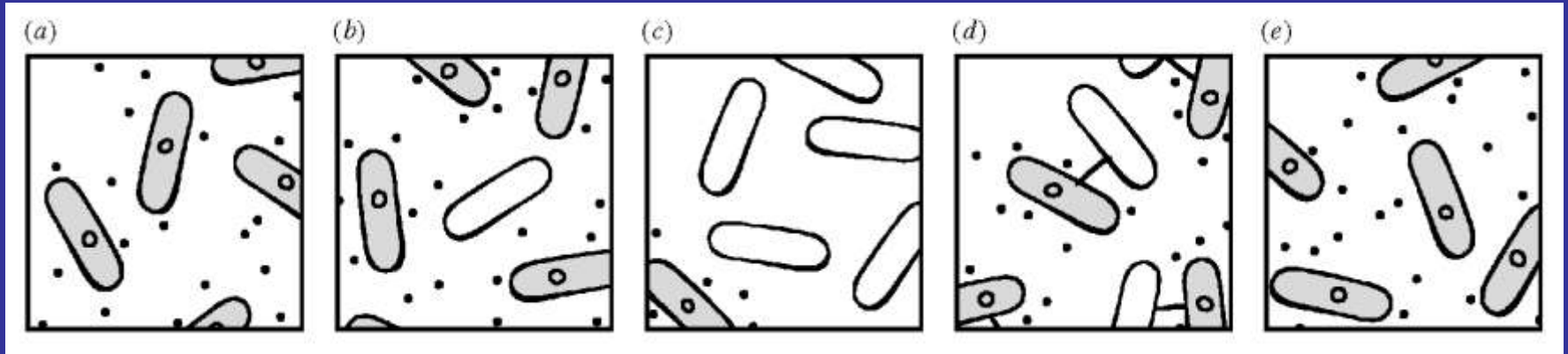
Plasmid Transfer



How are plasmids maintained?

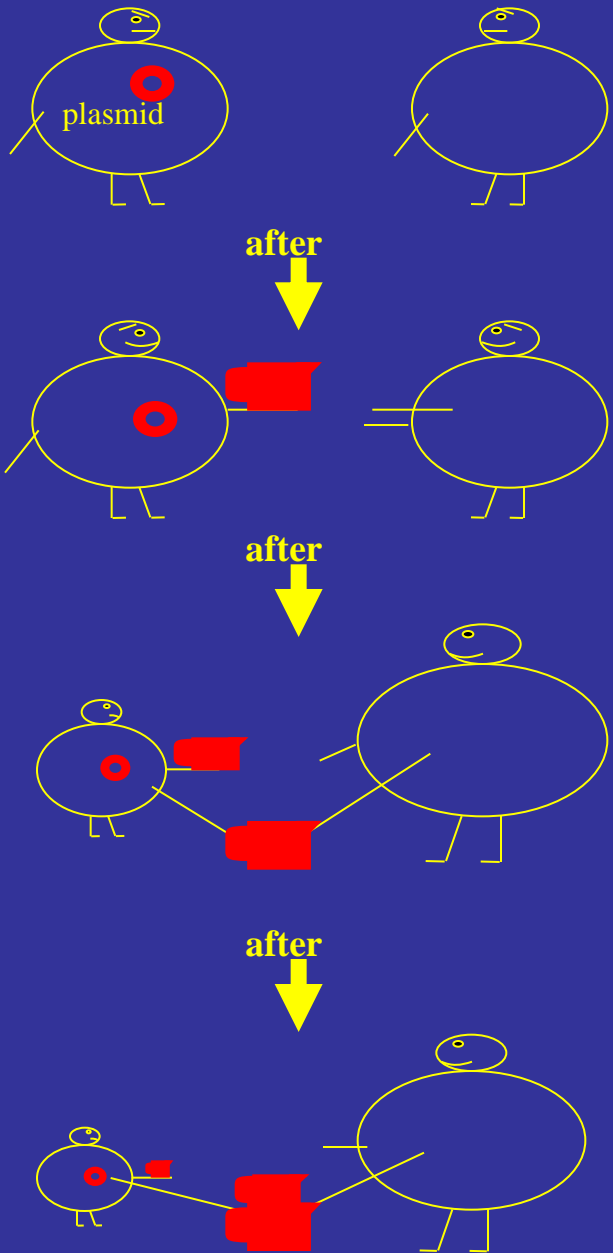
- They have “beneficial” genes.
- They transfer fast enough as to compensate for their cost
- Social causes (Smith J, 2001 Proc. Roy. Soc.): “beneficial” genes are used outside cells => plasmid transfer forces neighboring cells to work for the group. This is to prevent cheaters.

The Social Evolution of Bacterial Pathogenesis

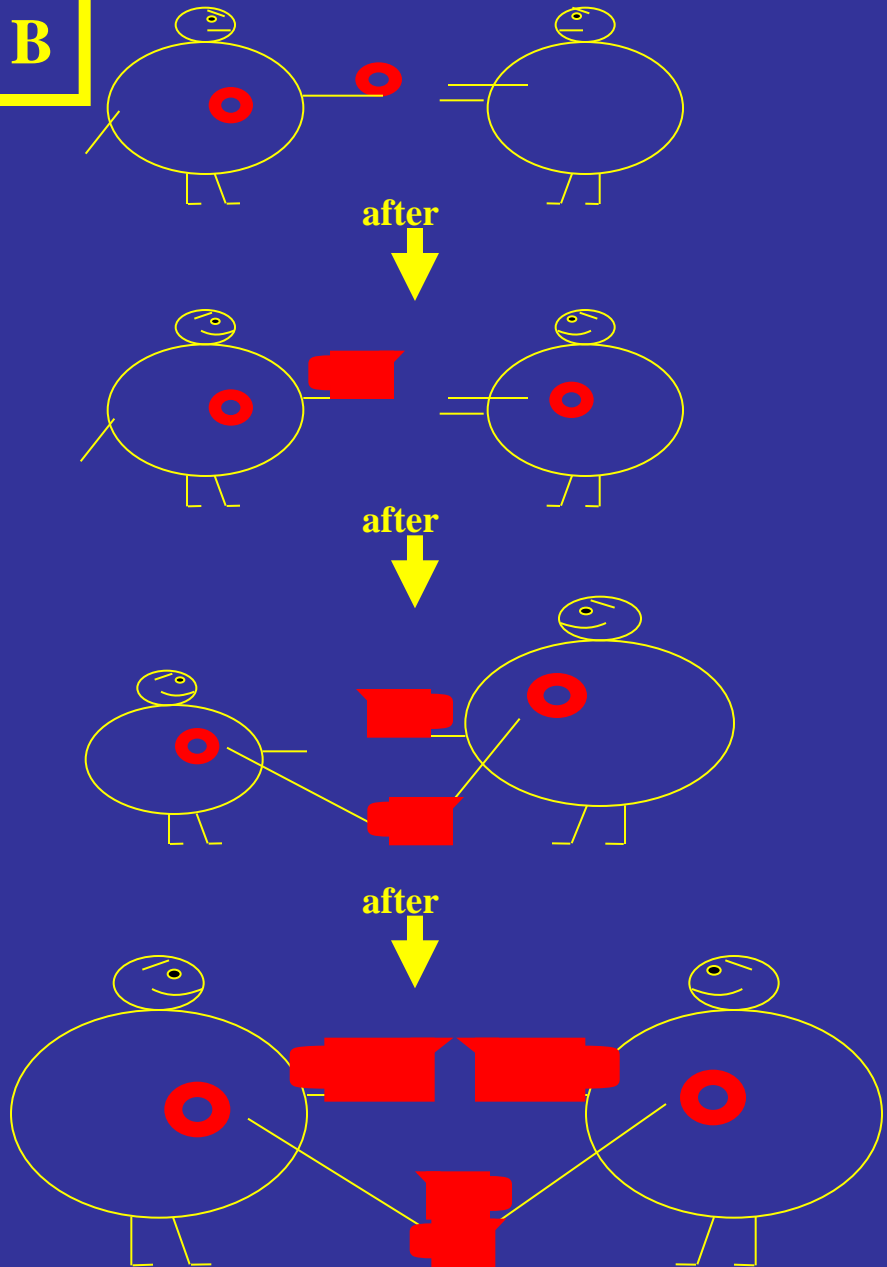


“Cheater Hypothesis” Picture from paper by Jeff Smith 2001 Proc Roy Soc

A



B



Adapted from E.O.Wilson's *Sociobiology* 1975

Experiments with plasmids R1, R16a and RP4

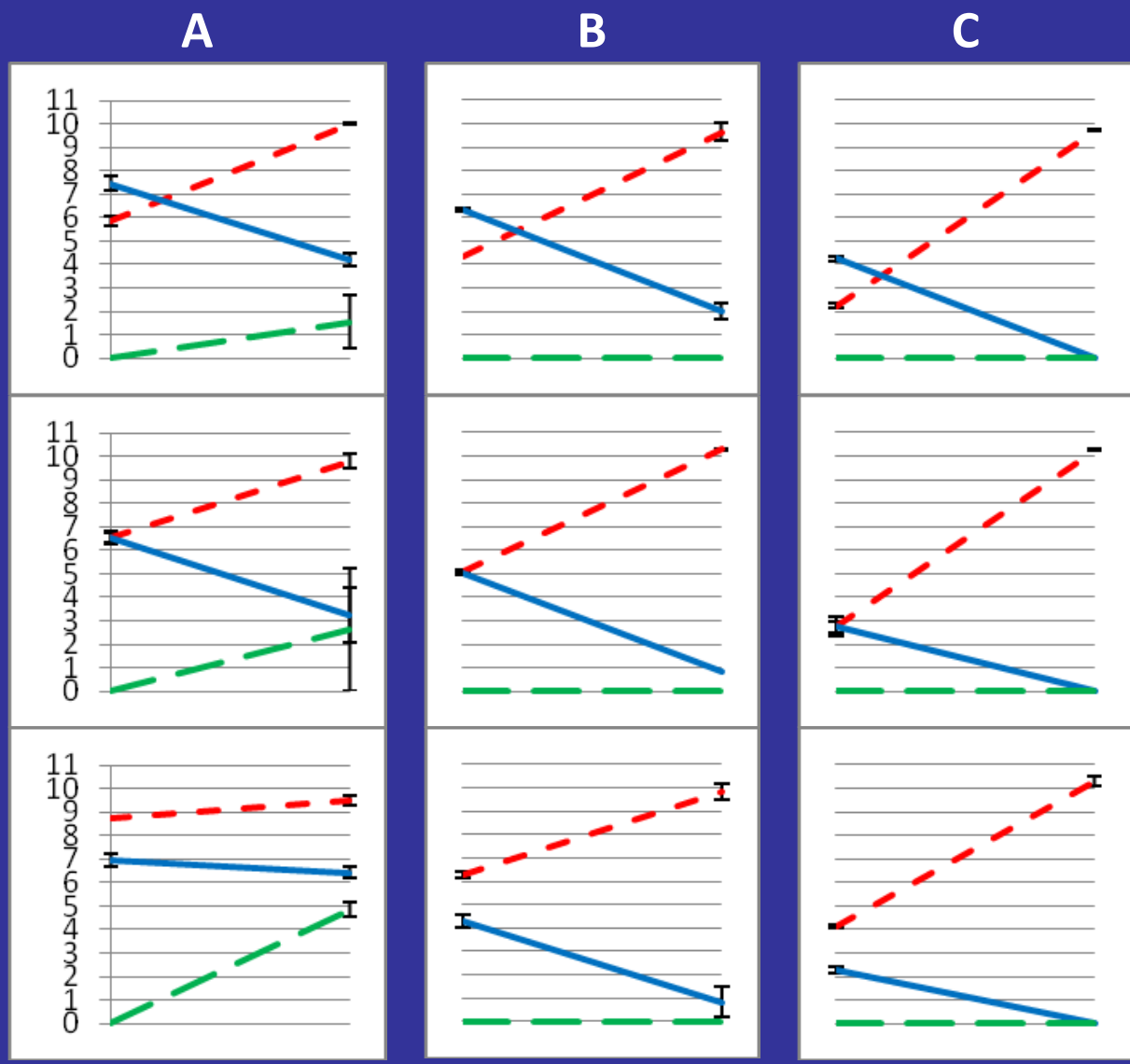
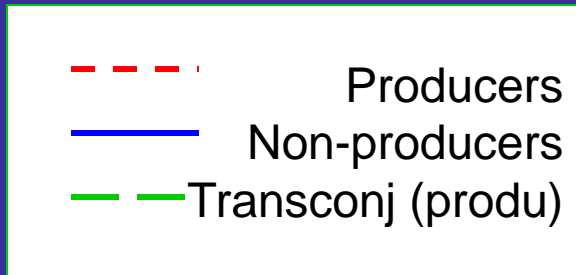
Conjugative plasmid with the same bla genes (R1)

1P:100NP

1P:1NP

Strong protection =>

100P:1NP



Note: Without producers, all sensitive cells would die

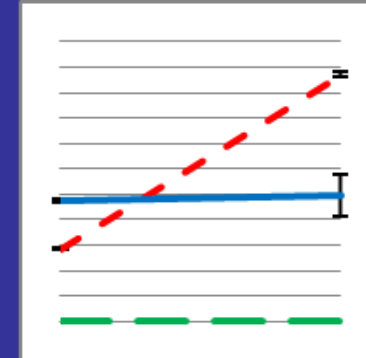
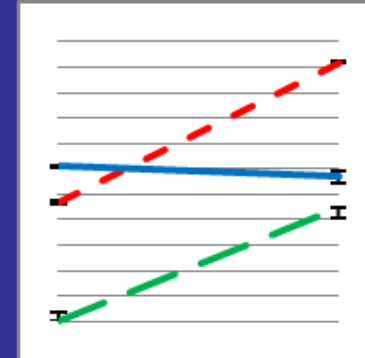
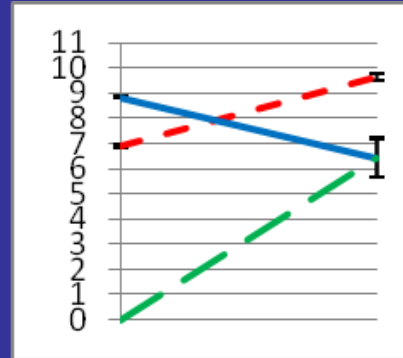
Conjugative plasmid with bla genes (R16a)

A

B

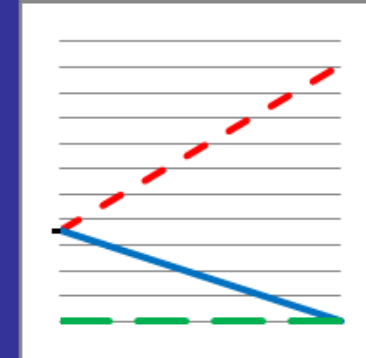
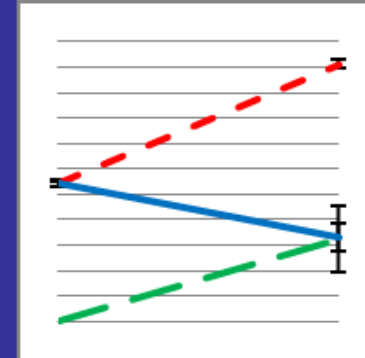
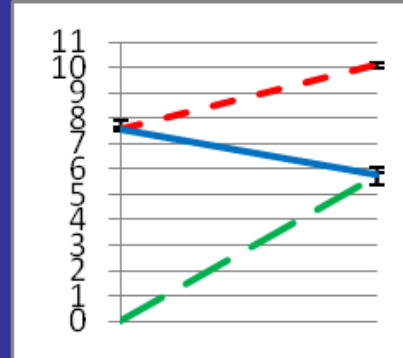
C

1P:100NP

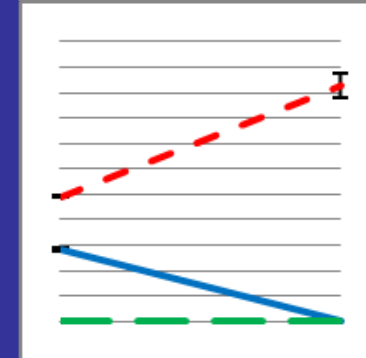
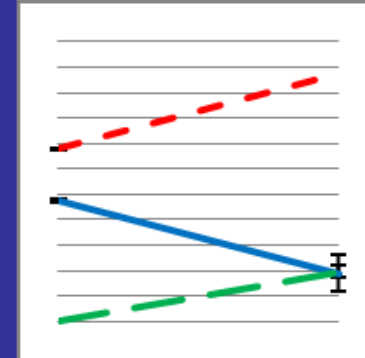
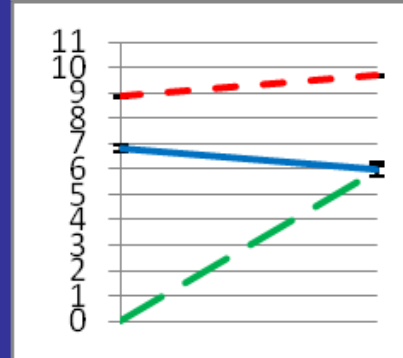


No protection or weak protection

1P:1NP



100P:1NP



- Producers
- Non-producers
- Transconj (produ)

Conjugative plasmid with bla genes (RP4)

1P:100NP

No protection or weak protection

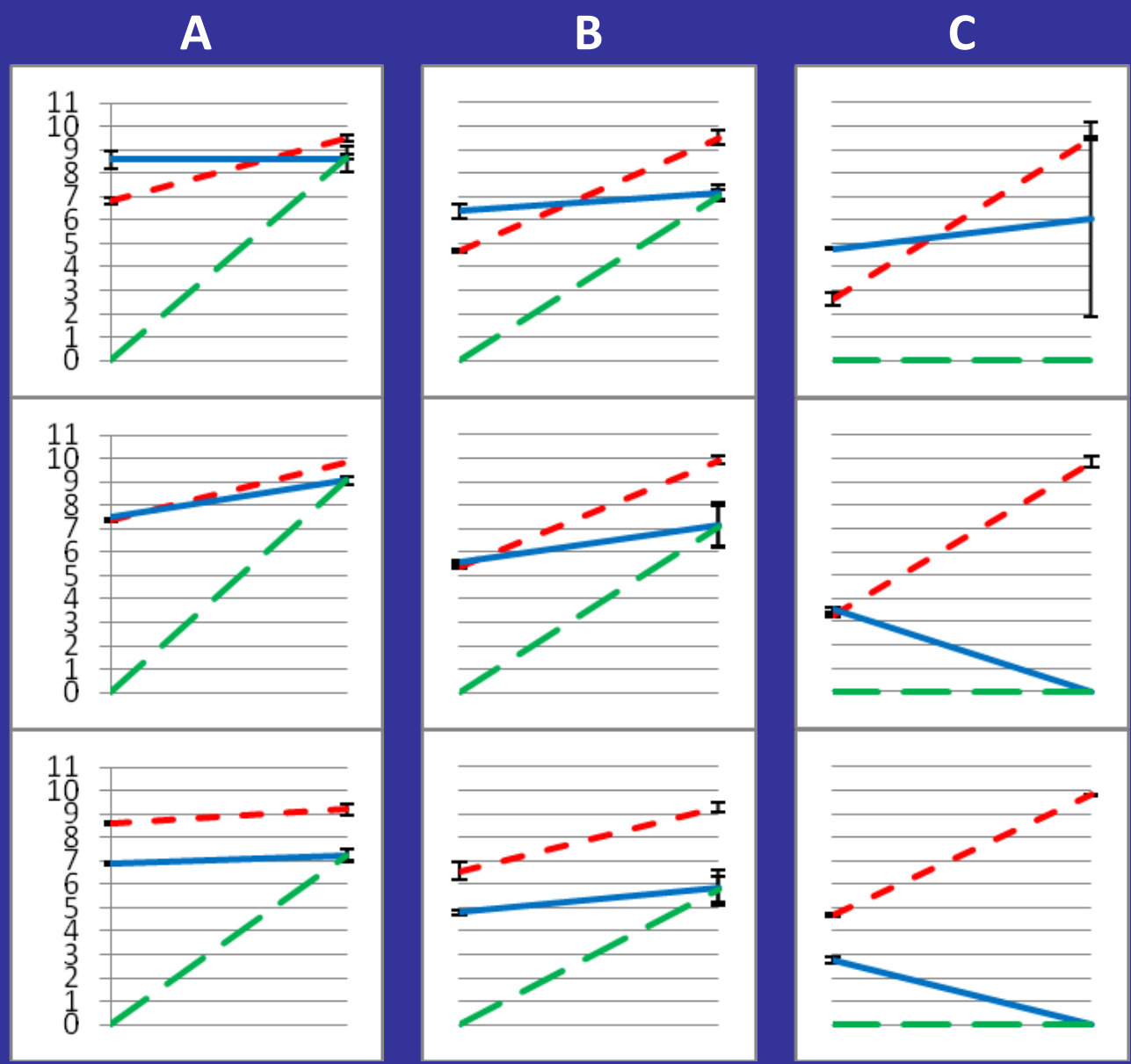
Strong protection? =>
Not sure

1P:1NP

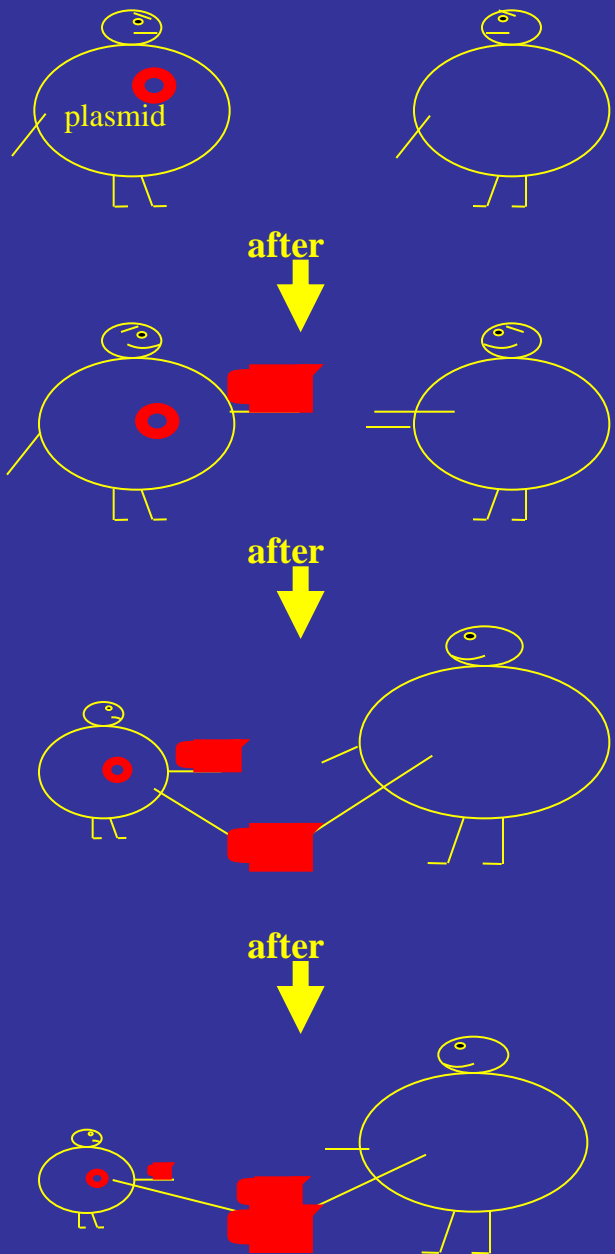
Strong protection? =>
Not sure

100P:1NP

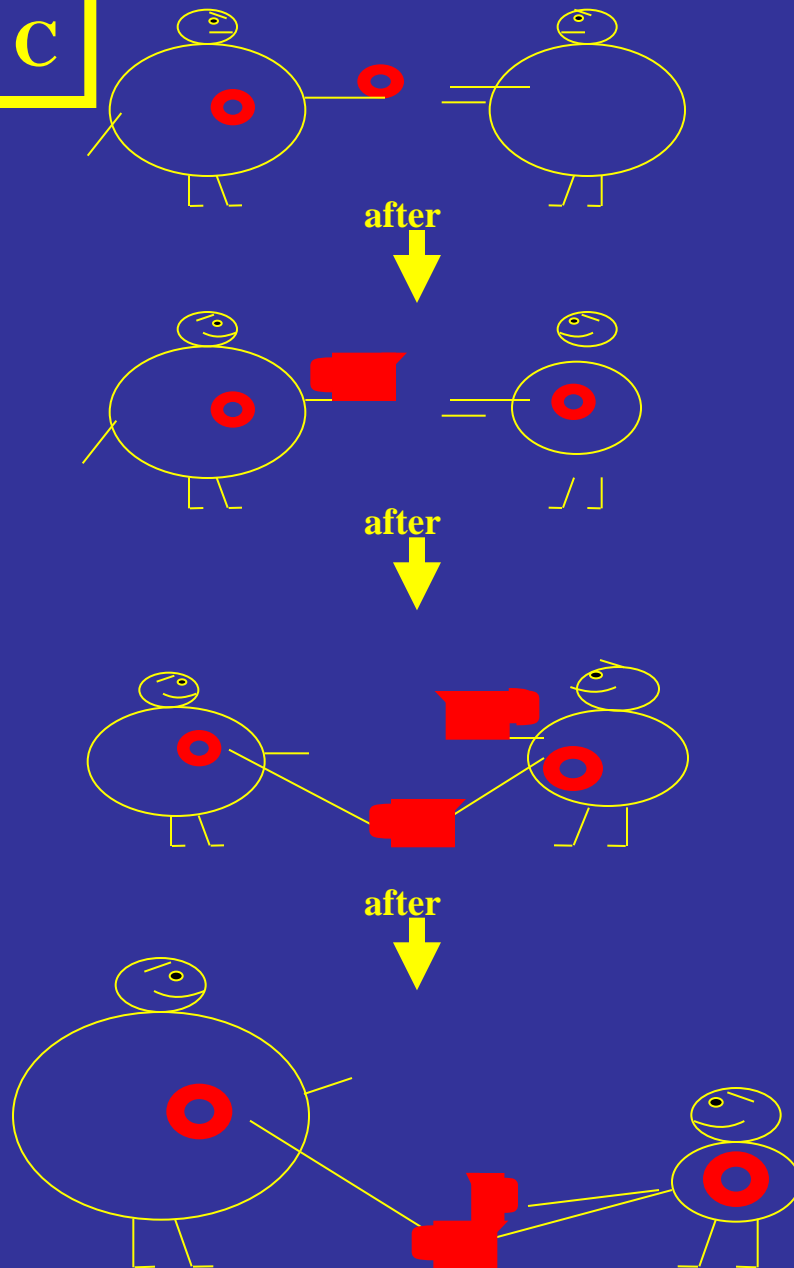
- - - Producers
- Non-producers
- - - Transconj (produ)



A



C



Adapted from E.O.Wilson's *Sociobiology* 1975

Sharing beta-lactamase but...

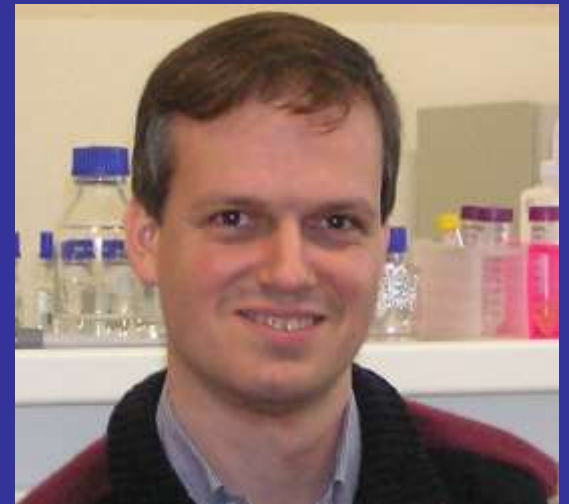
- Beta-lactamase is useful only when the antibiotic is present
- Meanwhile, when it is not present, fitness of recipient cells is decreased.
- Which may mean that plasmids are being used as a harmful device

Hypothesis to explain existence of plasmids

- Bacteria use plasmids as a biological weapon. Before that, bacteria and plasmids establish a mutualistic relationship.
- Experiments have been done using a Gram-species. But one expects different results with Gram+ bacteria.
- Virulence factors may account for the existence of plasmids, because many of them are *explicitly* secreted!

Many Thanks to:

- Iolanda Domingues
- Luis M. Carvalho
- ESF/EUROCORES/TECT
- FCT
- Eörs Szathmary, Eva Hoogland, Ronald Noë, Claire Rustat-Flinton



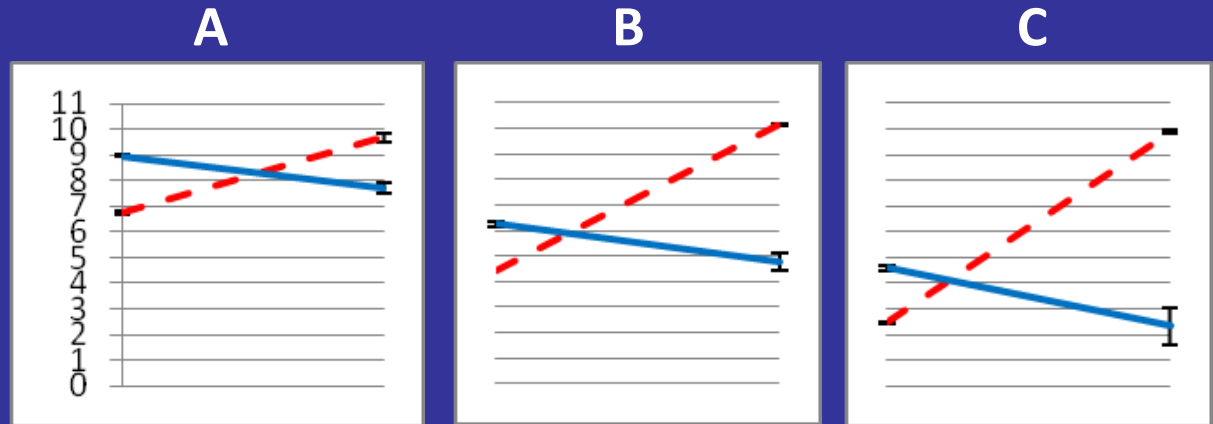
An example with plasmids

R1 and pBR322

- Conjugative plasmid:
 - R1 (similar to F plasmid, but isolated in 1962).
 - Confers resistance to 6 antibiotics
 - Including resistance to Ampicillin due to...
 - transposon **Tn3** containing bla genes
- Non-conjugative plasmid:
 - This **Tn3** is in the artificial plasmid pBR322 (since 1977)
- Therefore R1 and pBR322 have the same bla genes

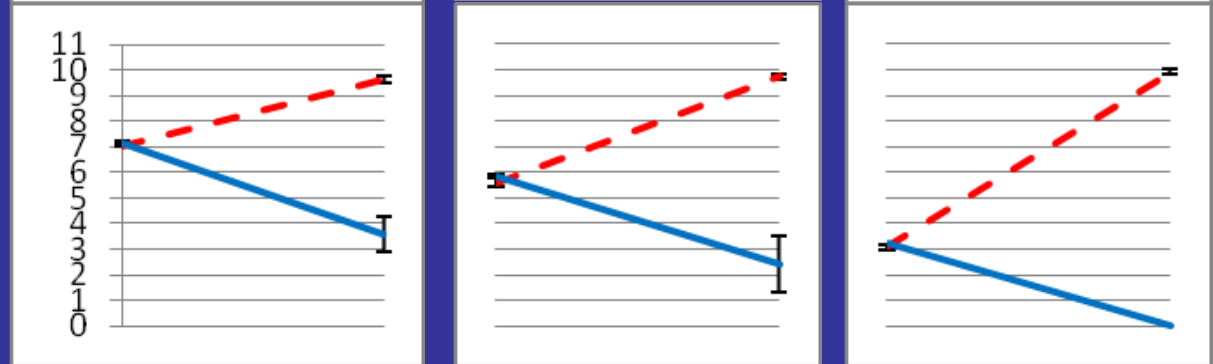
Non-conjugative plasmid with bla genes (pBR322)

1P:100NP

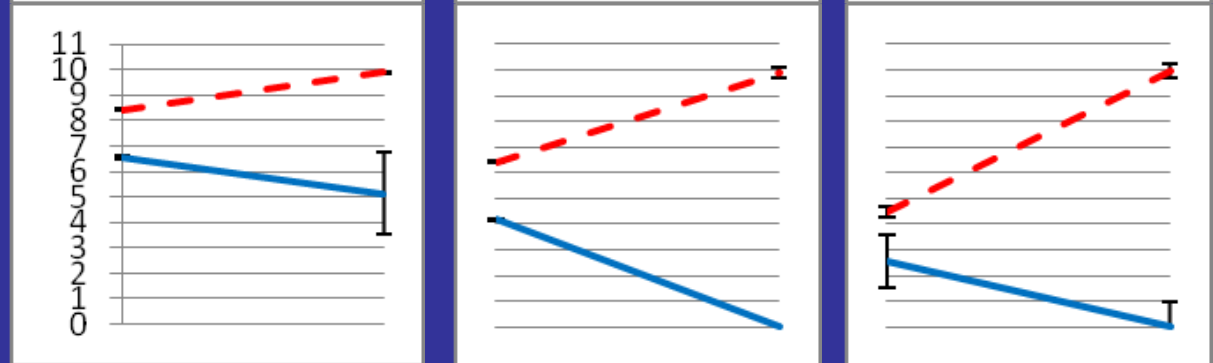


No protection or weak protection

1P:1NP



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--- Producers
— Non-producers
--- Transconj (produ)

Note: Without producers, all sensitive cells would die