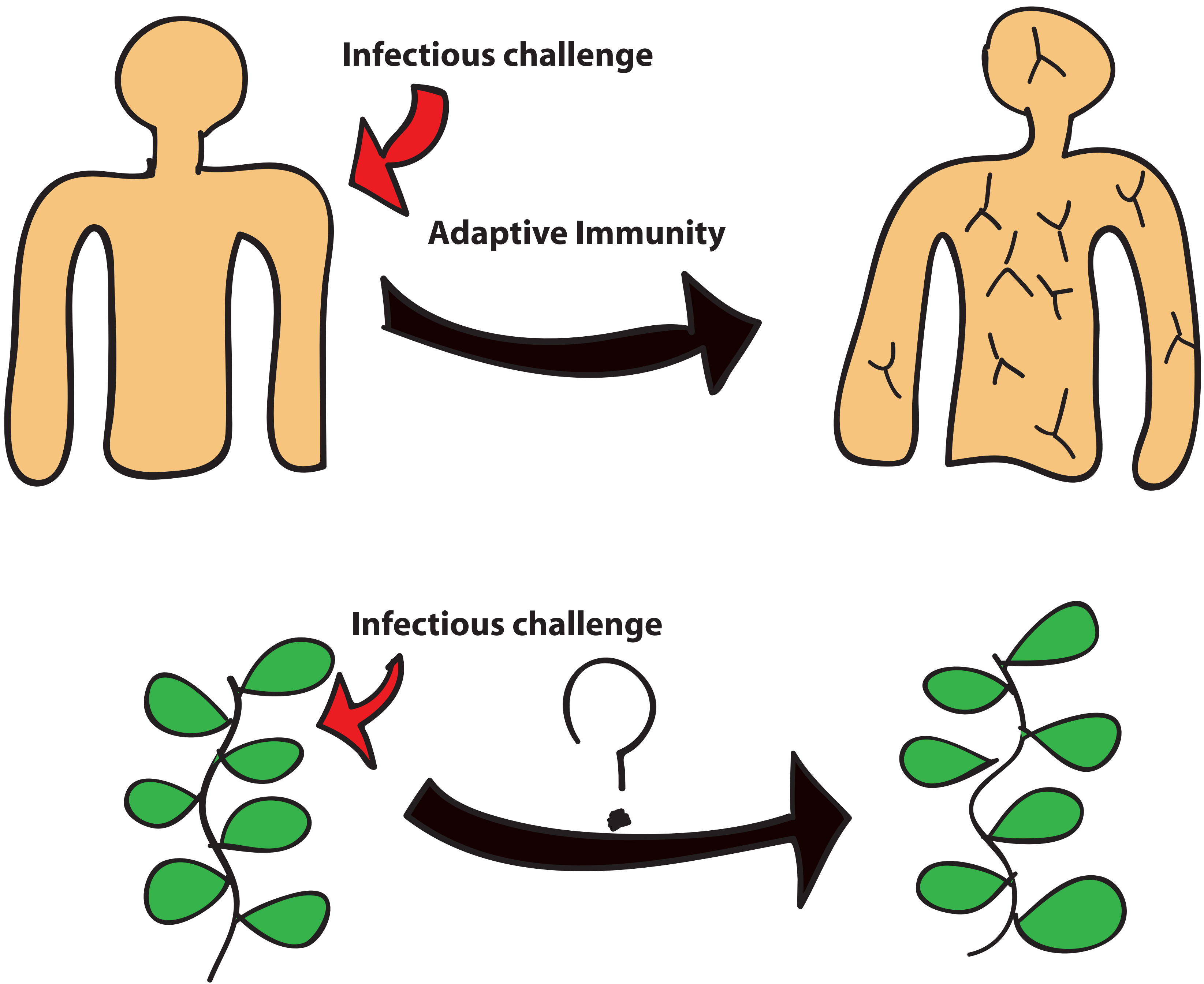
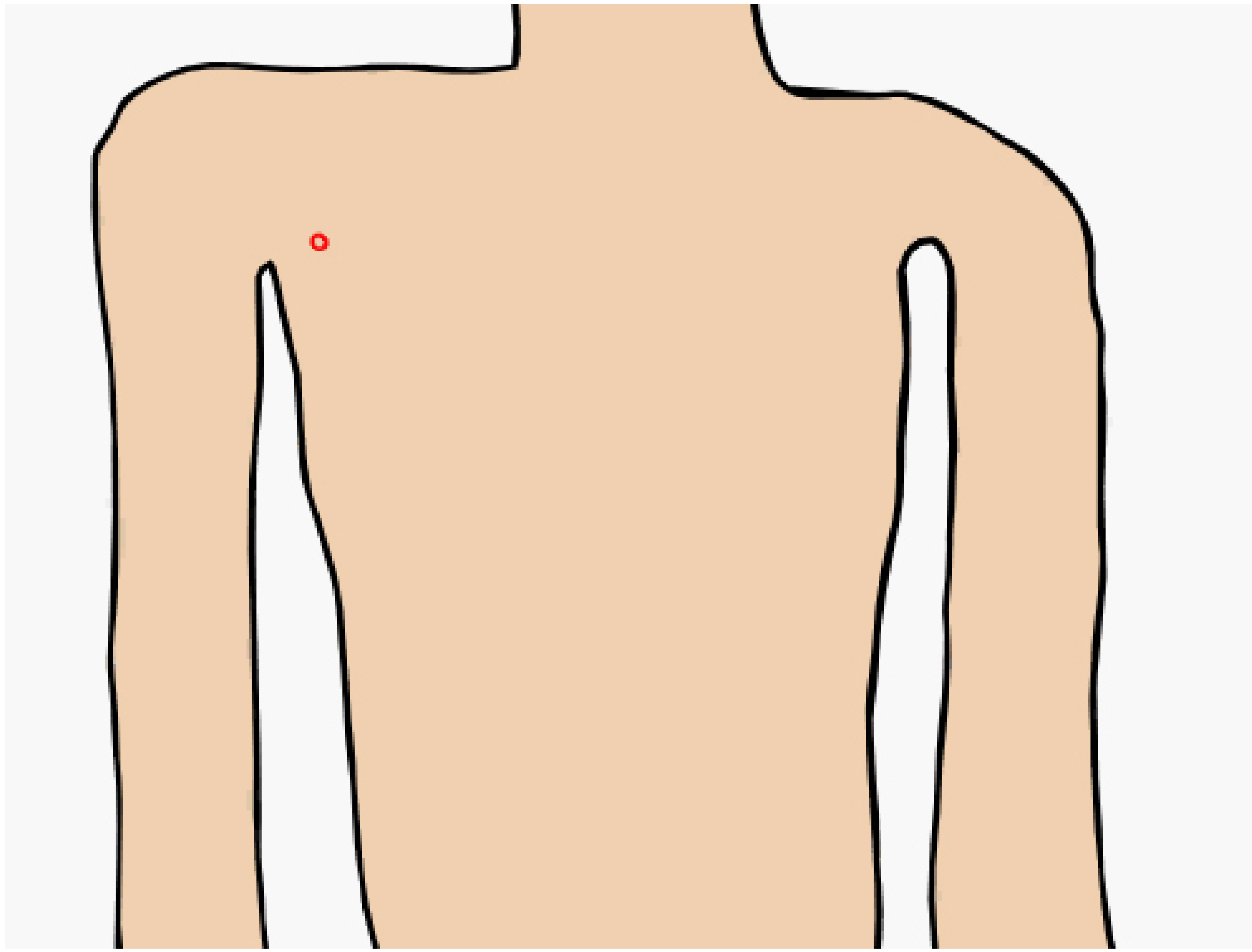
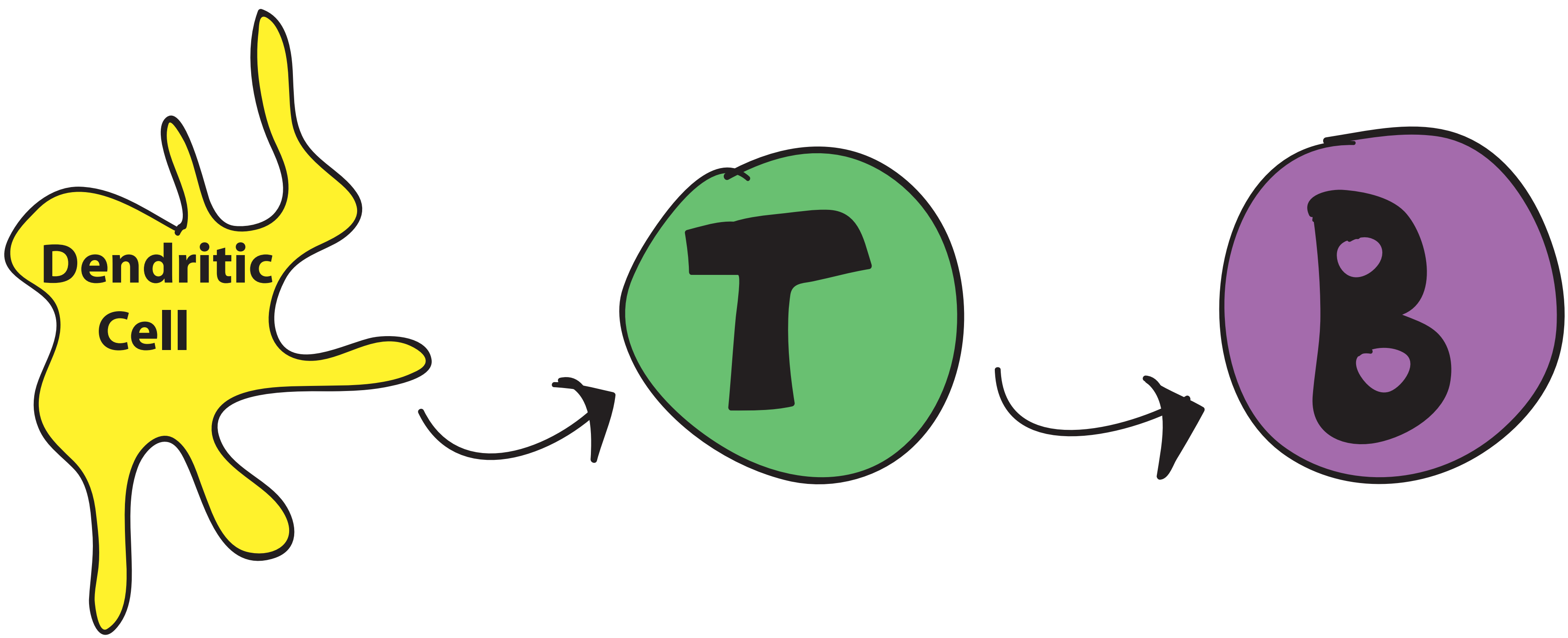
How do organisms with only an innate immune response have adaptive immunity?



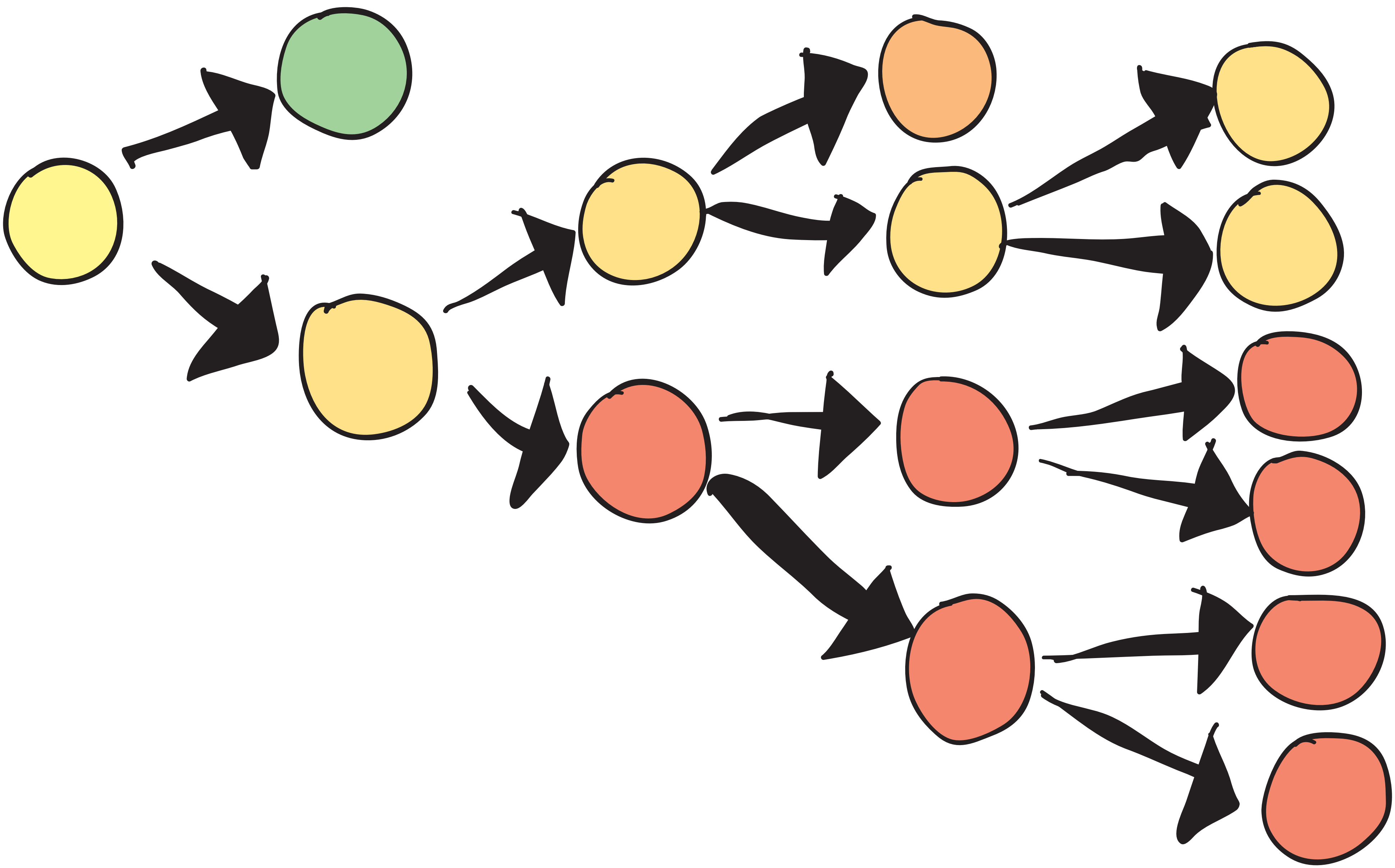
Immunity in humans is adaptive



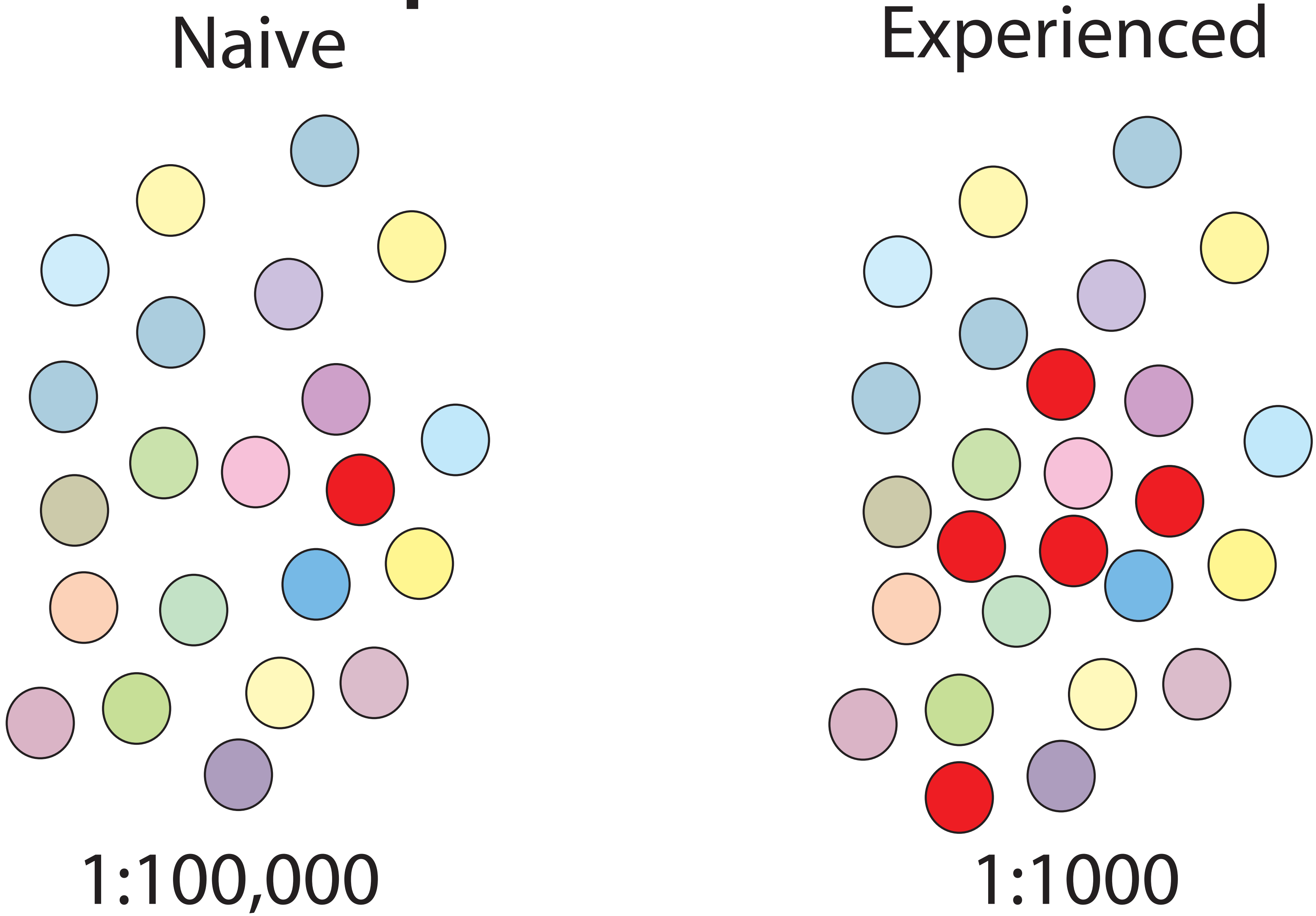
Information flow in the adaptive immune system



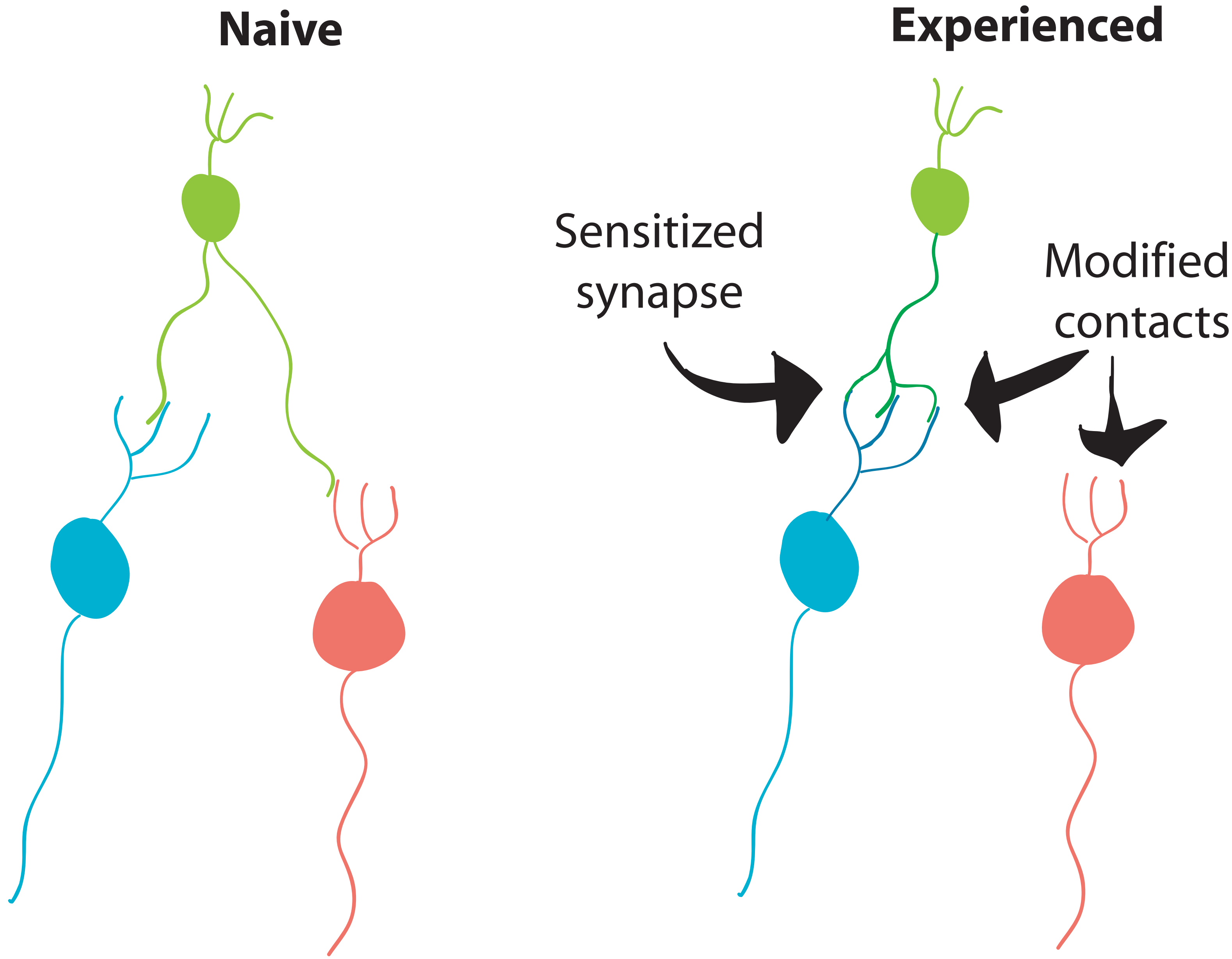
One source of adaptation is the modification of antibodies



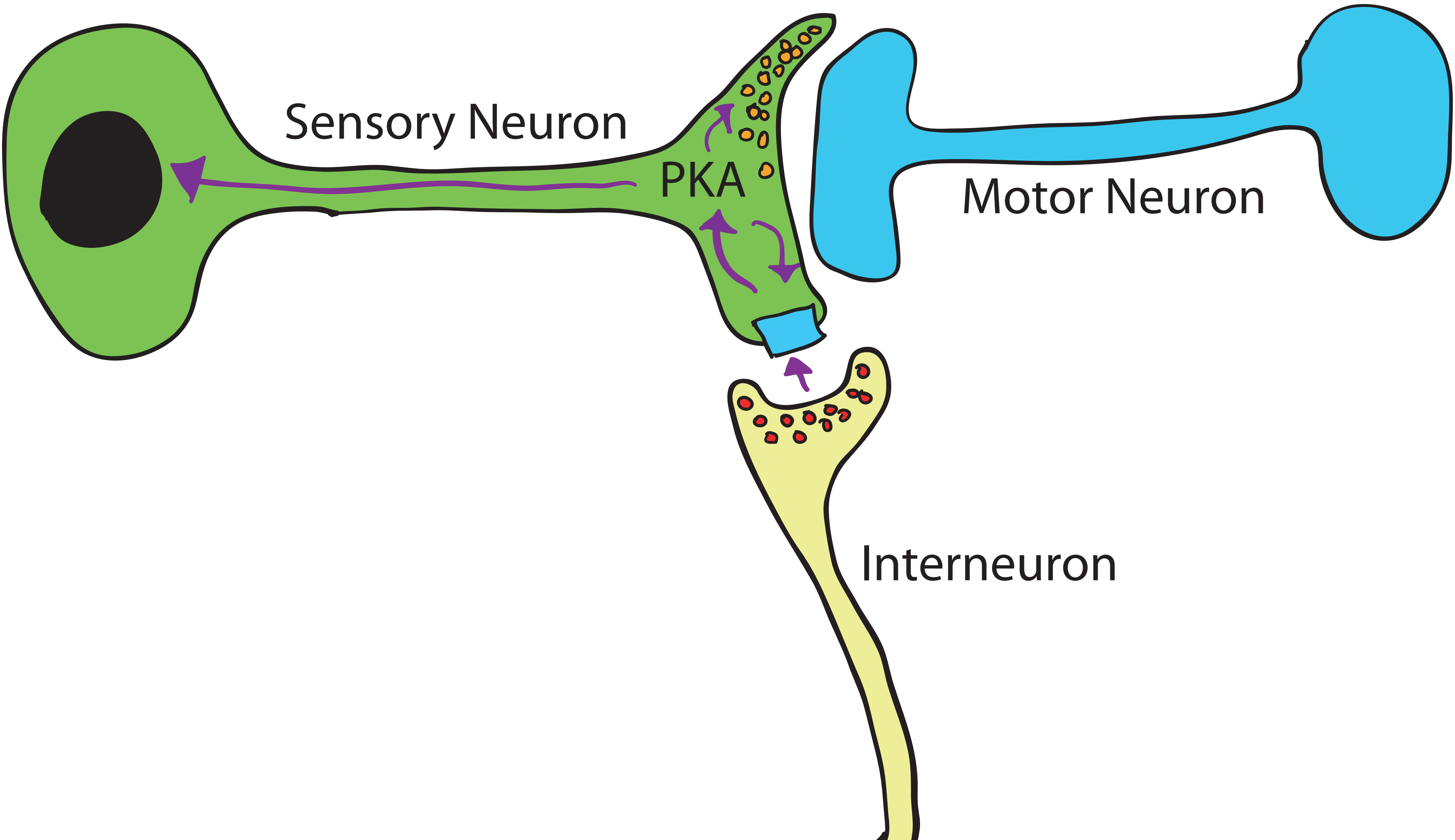
Memory comes from the amplification of specific T and B cells



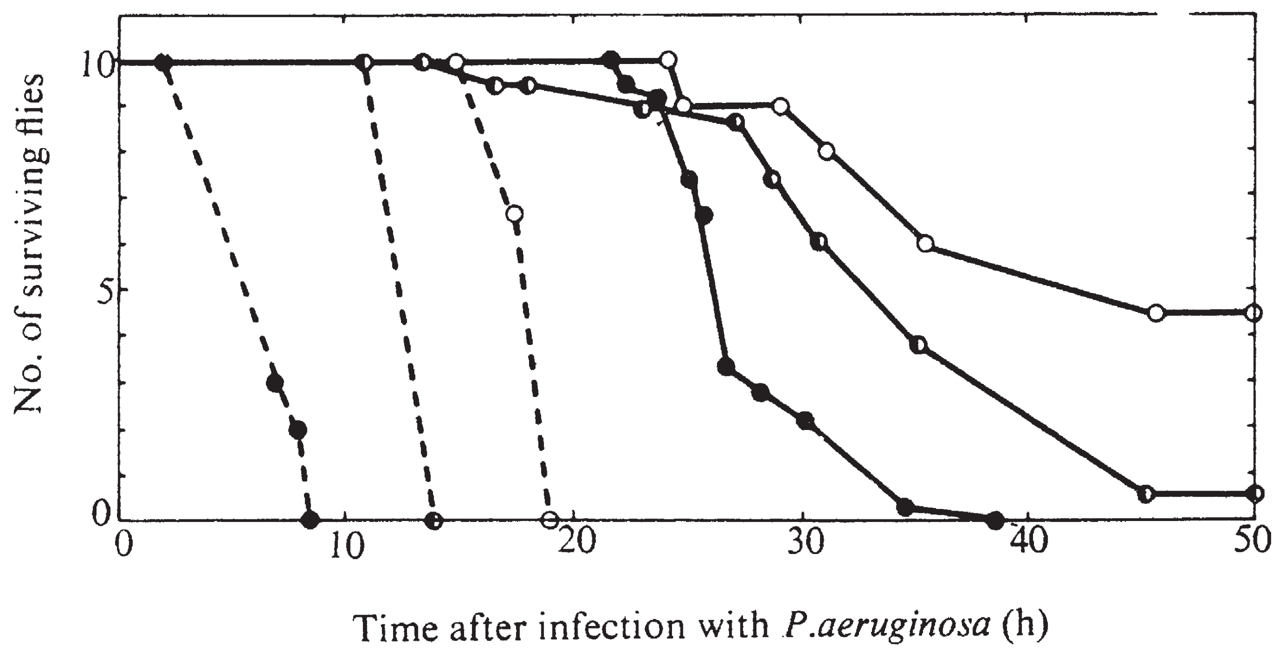
Memory in nervous system comes from long term changes in cells and changes in the network structure



Long term facilitation

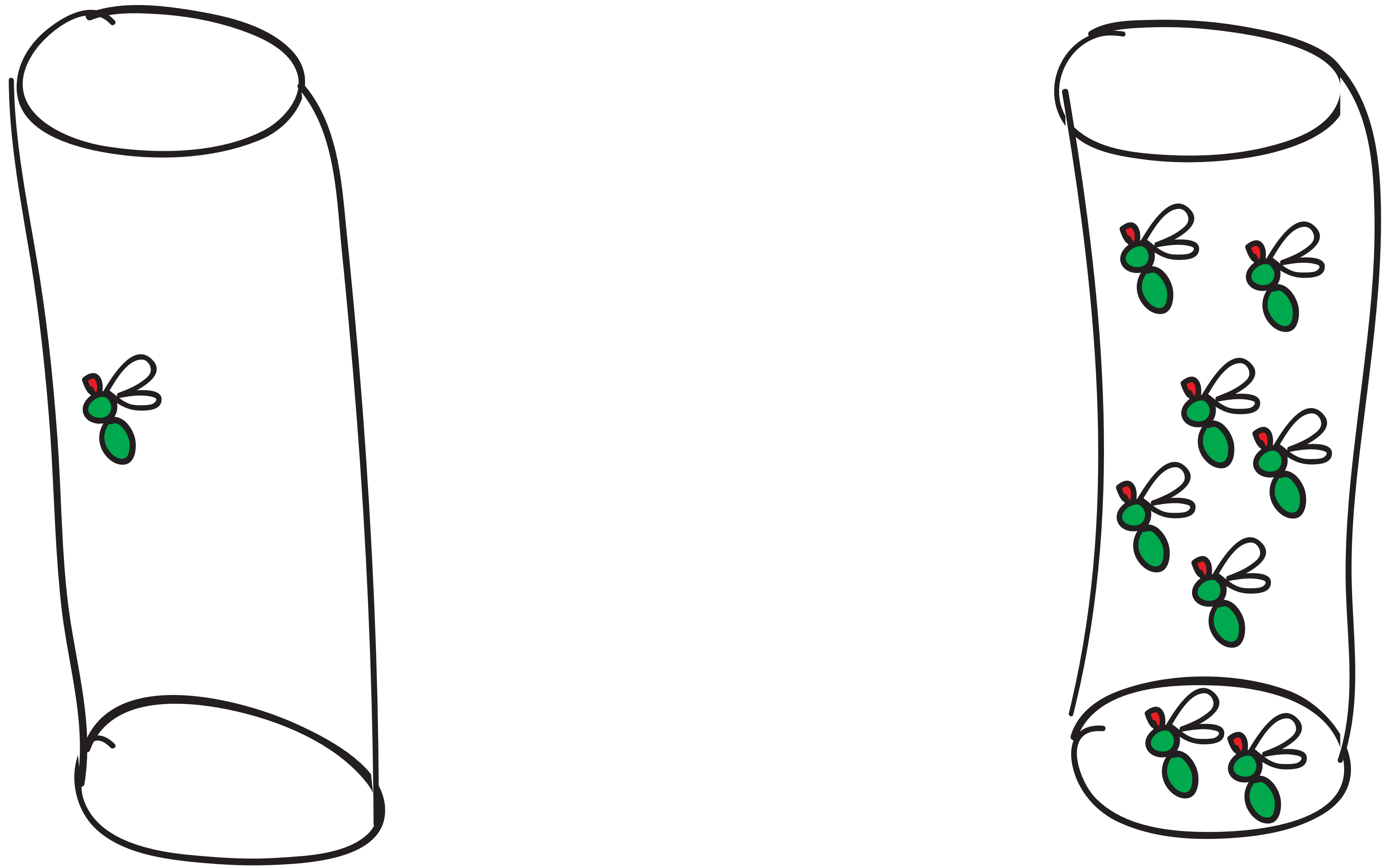


Short term adaptation in fruit flies

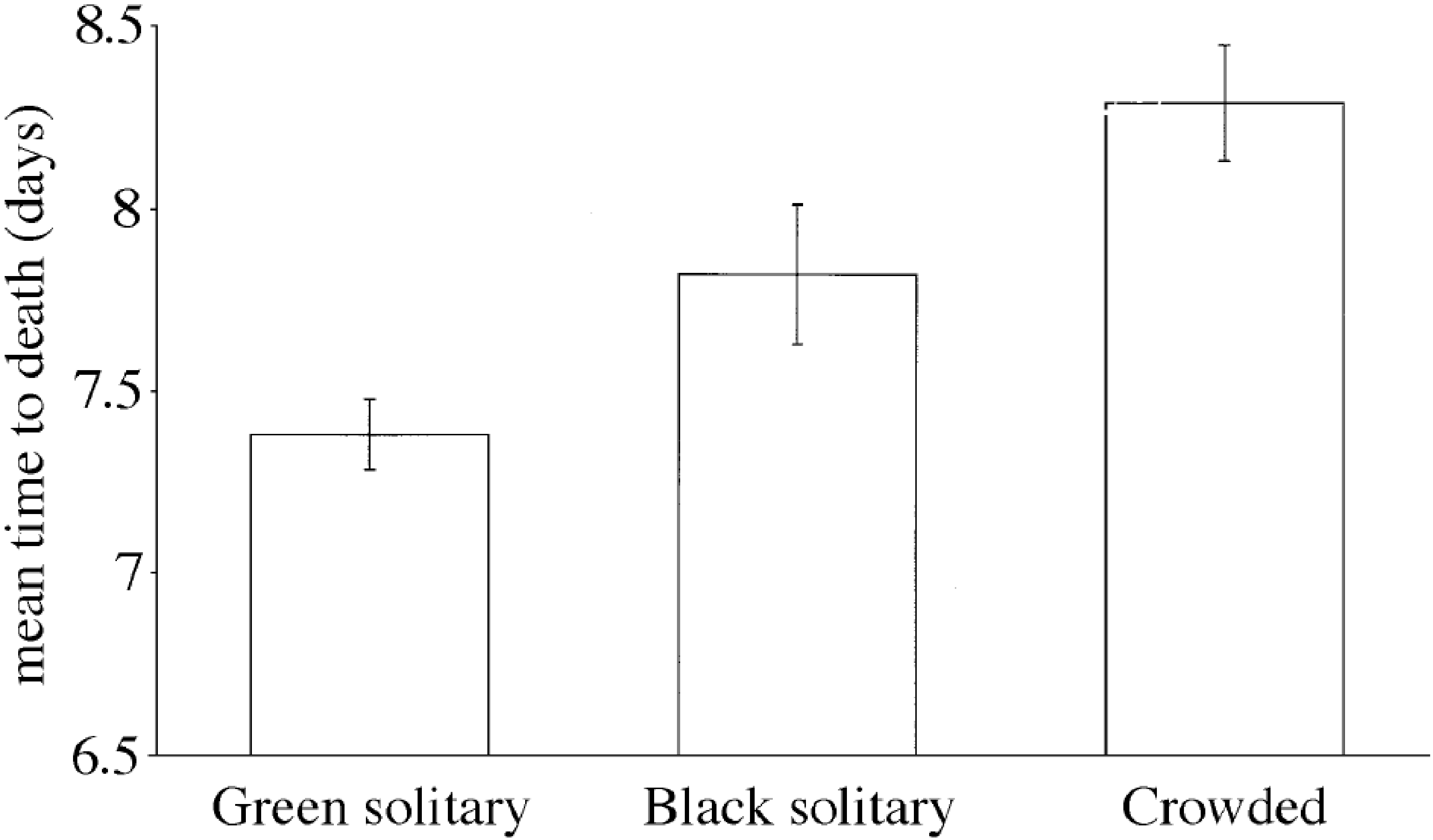


Boman et al Nature 1972 237: 232-235

Population density and immune status

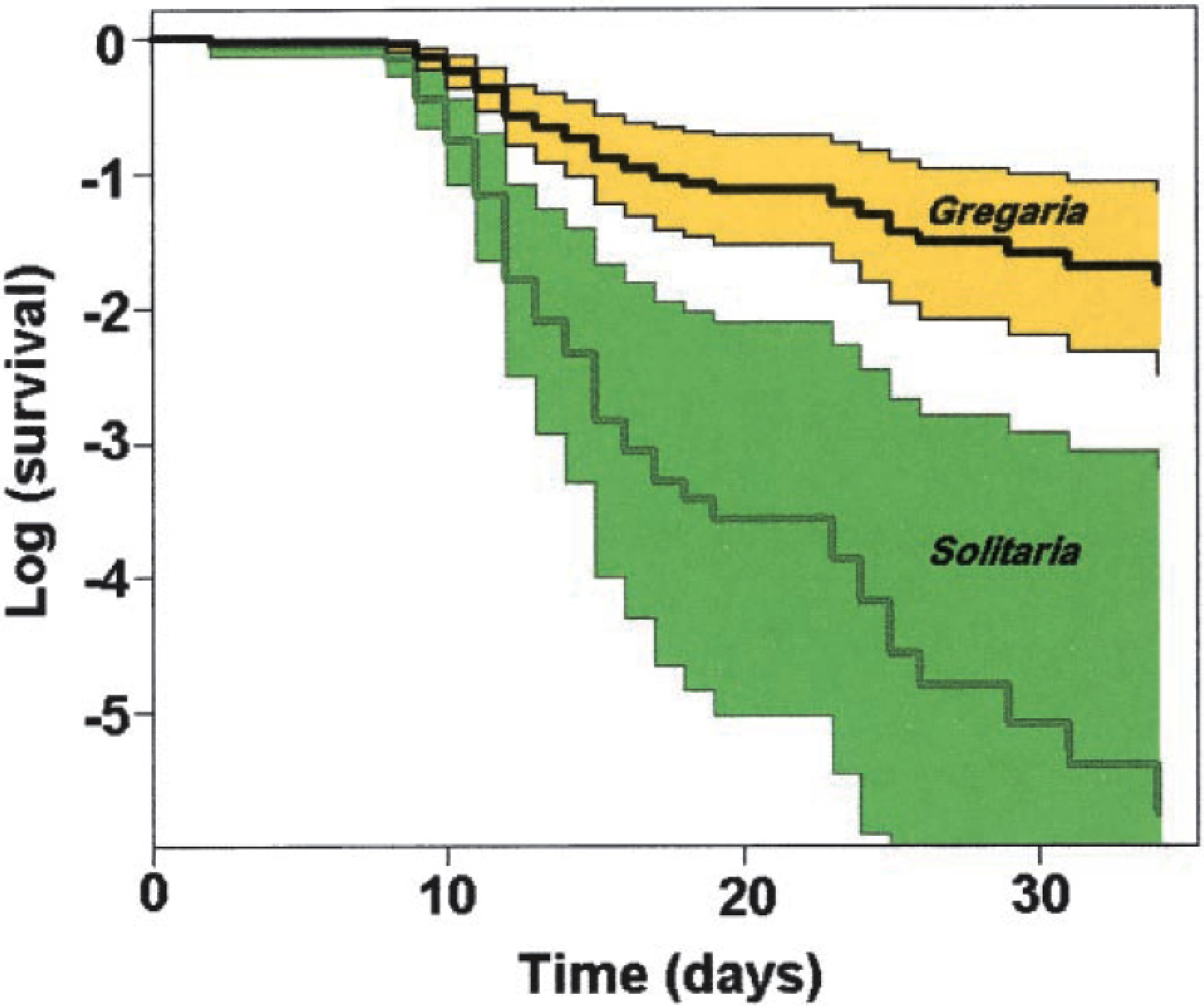


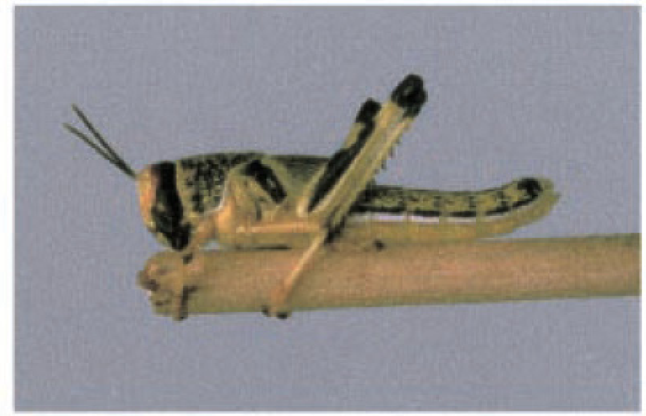
Virus sensitivity in crowded vs solitary caterpillars



Reeson et al. 1998 Proc. R. Soc. Lond. B 265: 1787-1791

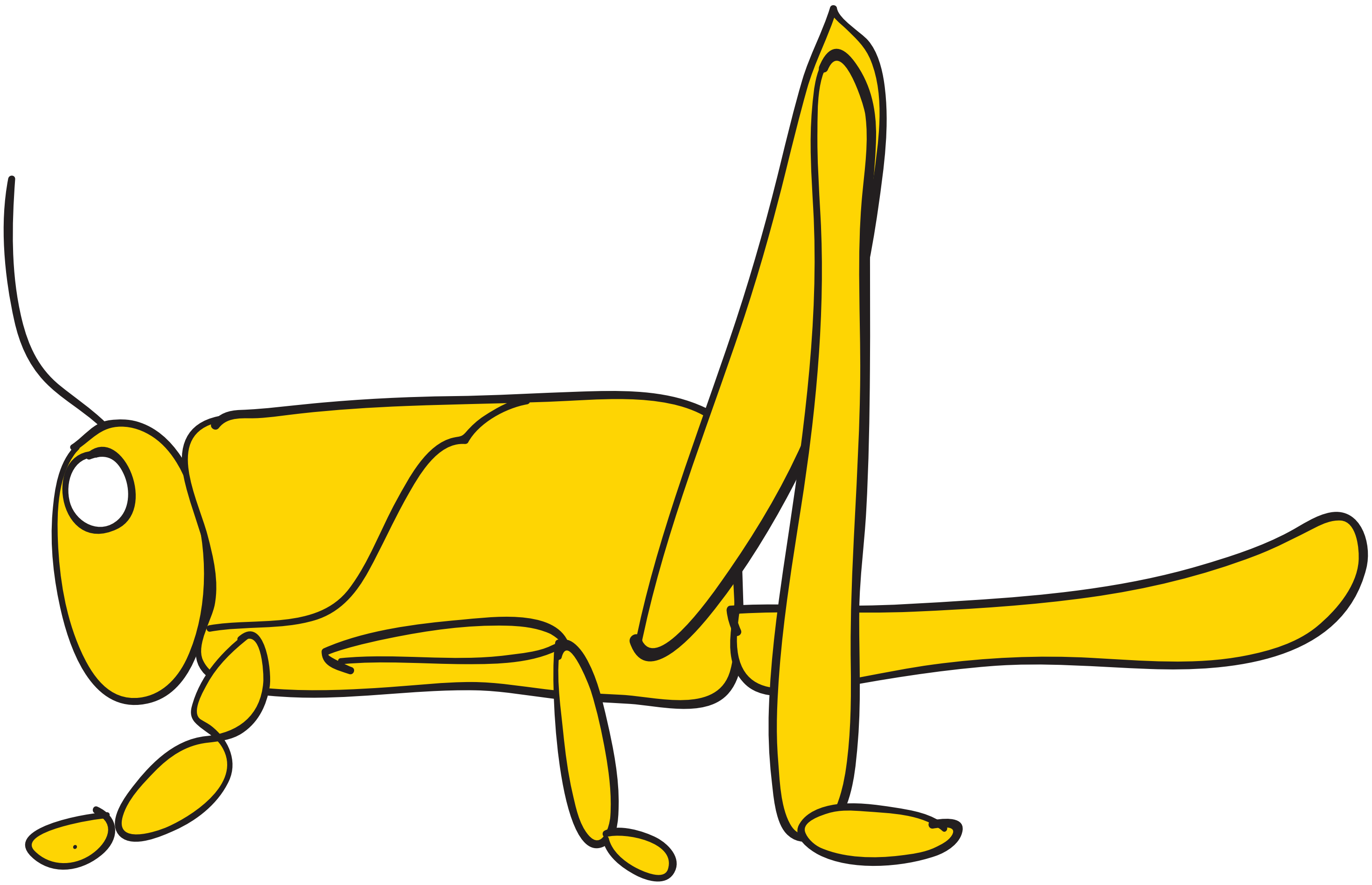
Density dependent immunity in locusts





Wilson et al. 2002 PNAS 99: 5471-5475

Maternal control of gregaria/solitaria ratio



Forced fever in female locusts causes them to increase the number of solitaria they produce

Treatment	Hatchling colour score 1	2	3	4	5	Total
Experiment 1						
Infected	14.6 ± 2.5%	6.4 ± 2.9%	7.4 ± 3.8%	6.8 ± 2.0%	64.8 ± 9.8%	1655
Control high	1.4 ± 0.6%	2.5 ± 1.5%	2.4 ± 1.1%	3.6 ± 1.6%	90.2 ± 4.7%	2042
Control medium	1.2 ± 0.4%	2.5 ± 0.6%	2.6 ± 1.0%	10.9 ± 2.0%	82.8 ± 1.5%	1402
Control low	1.3 ± 0.6%	3.3 ± 1.3%	9.3 ± 3.2%	7.7 ± 3.0%	78.5 ± 5.0%	648
Experiment 2						
'Fevered'	13.6 ± 4.6%	13.1 ± 6.0%	1.1 ± 0.9%	9.9 ± 5.5%	62.3 ± 12.6%	780
Control	4.4 ± 1.1%	11.5 ± 3.9%	4.7 ± 2.2%	12.0 ± 5.9%	67.3 ± 4.8%	1031

Elliot et al. 2003 Ecology Letters 6: 830-836

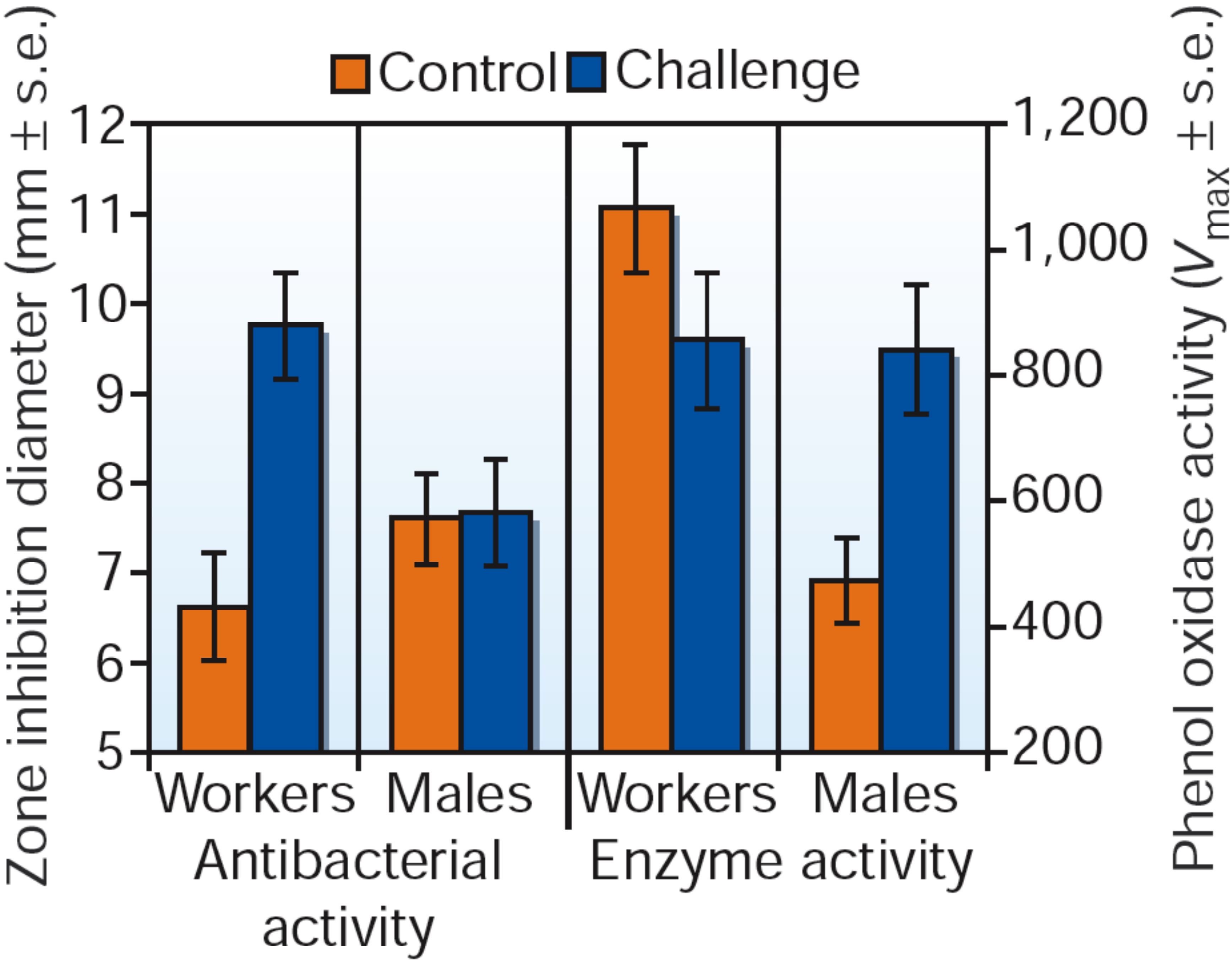
Maternal transmission of adaptation to BT toxin

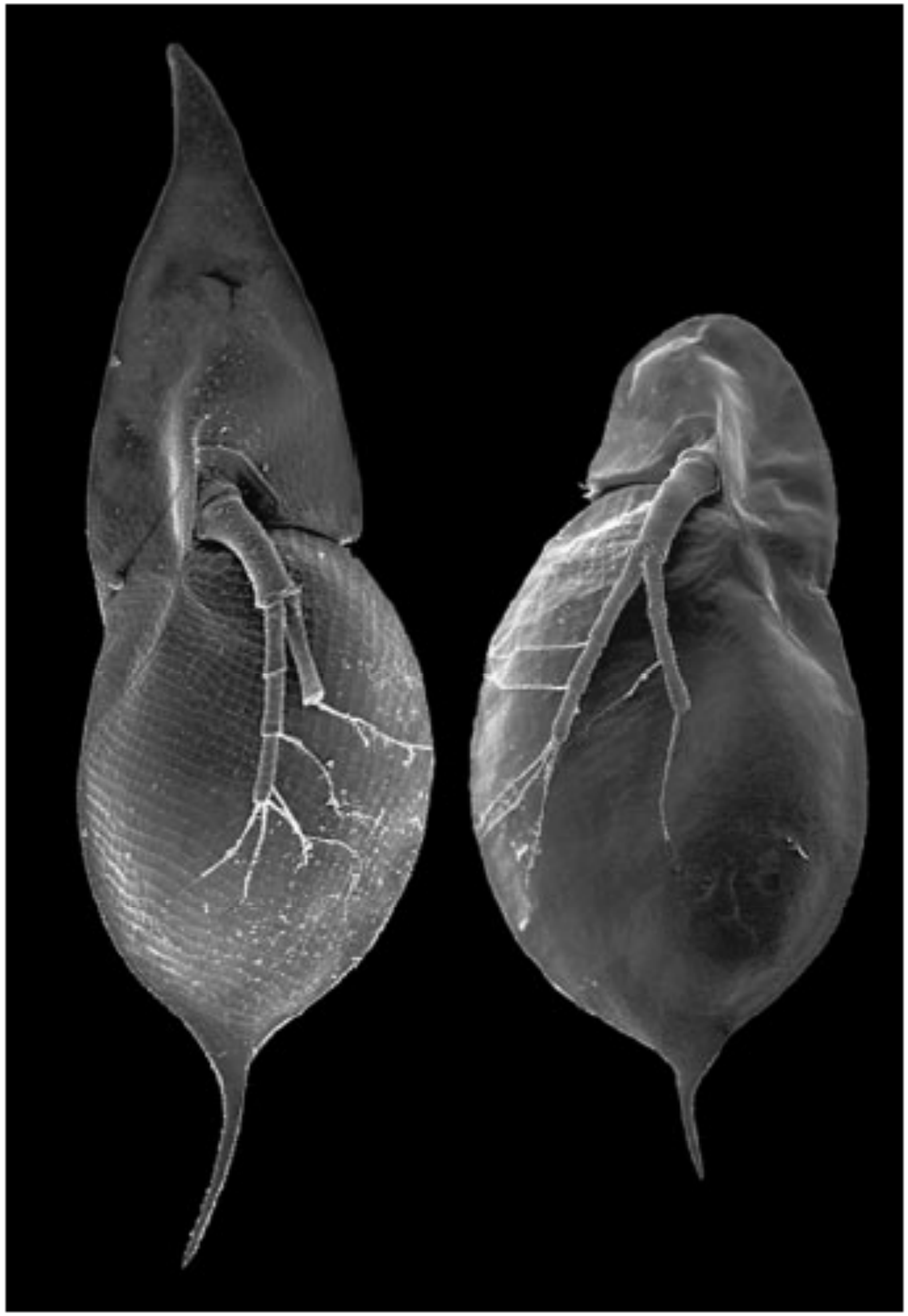
Cross	LC_{50} (ppm)	95% C.I.	Slope	RR
Susceptible	231	203–262	2.62	—
S×T	476	372–580	2.39	2
T×S	1,200	1,038–1,372	2.22	5.2
Tolerant	1,816	1,489–2,227	2.02	7.9

Differences in control mortality (mean 3.51%) were not significant (F = 0.185, P = 0.905). C.I., confidence interval; RR, resistance ratio.

Rahman et al. 2004 PNAS 101: 2696-2699

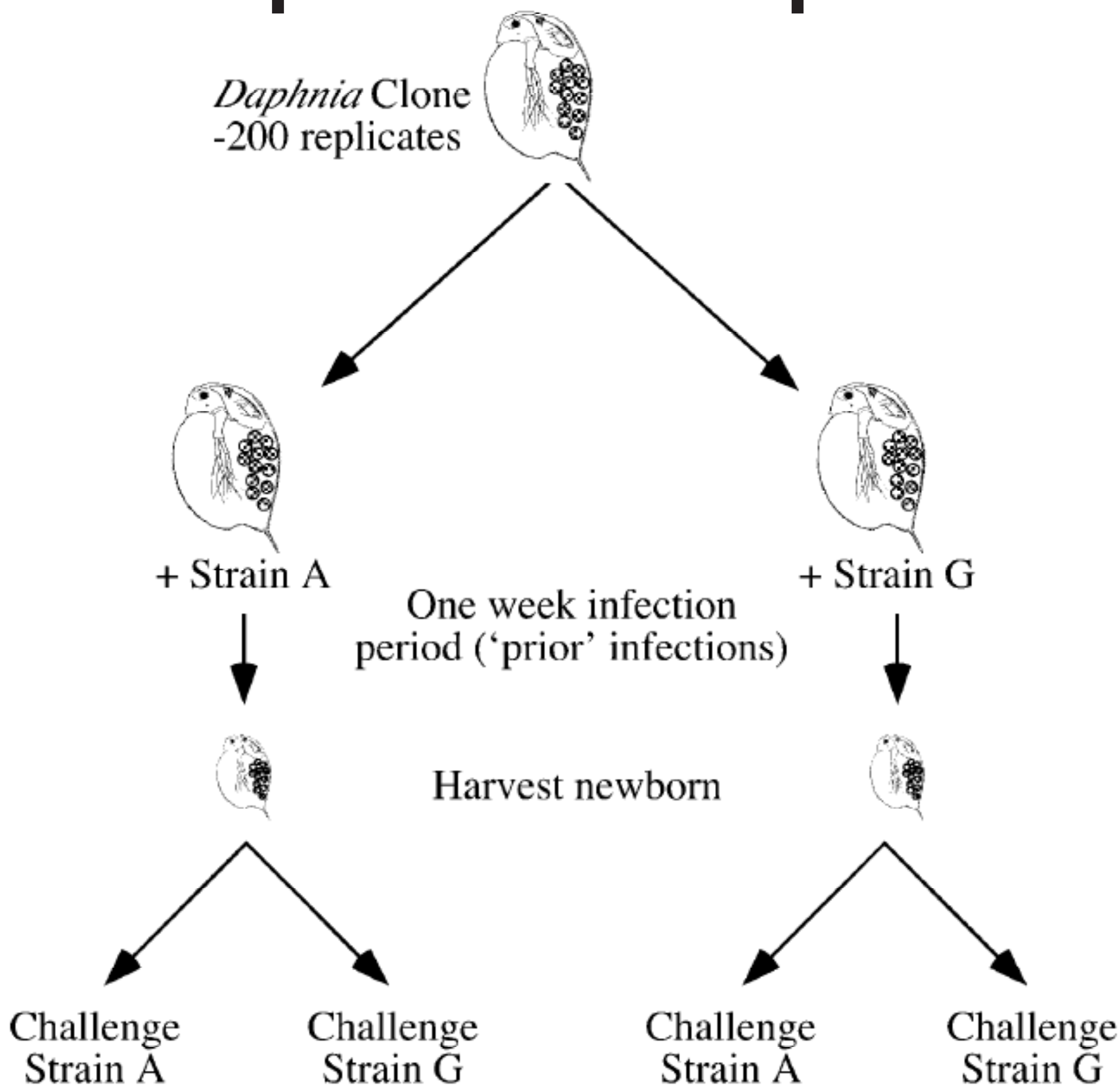
Honeybee offspring can have activated immune systems if the hive is infected

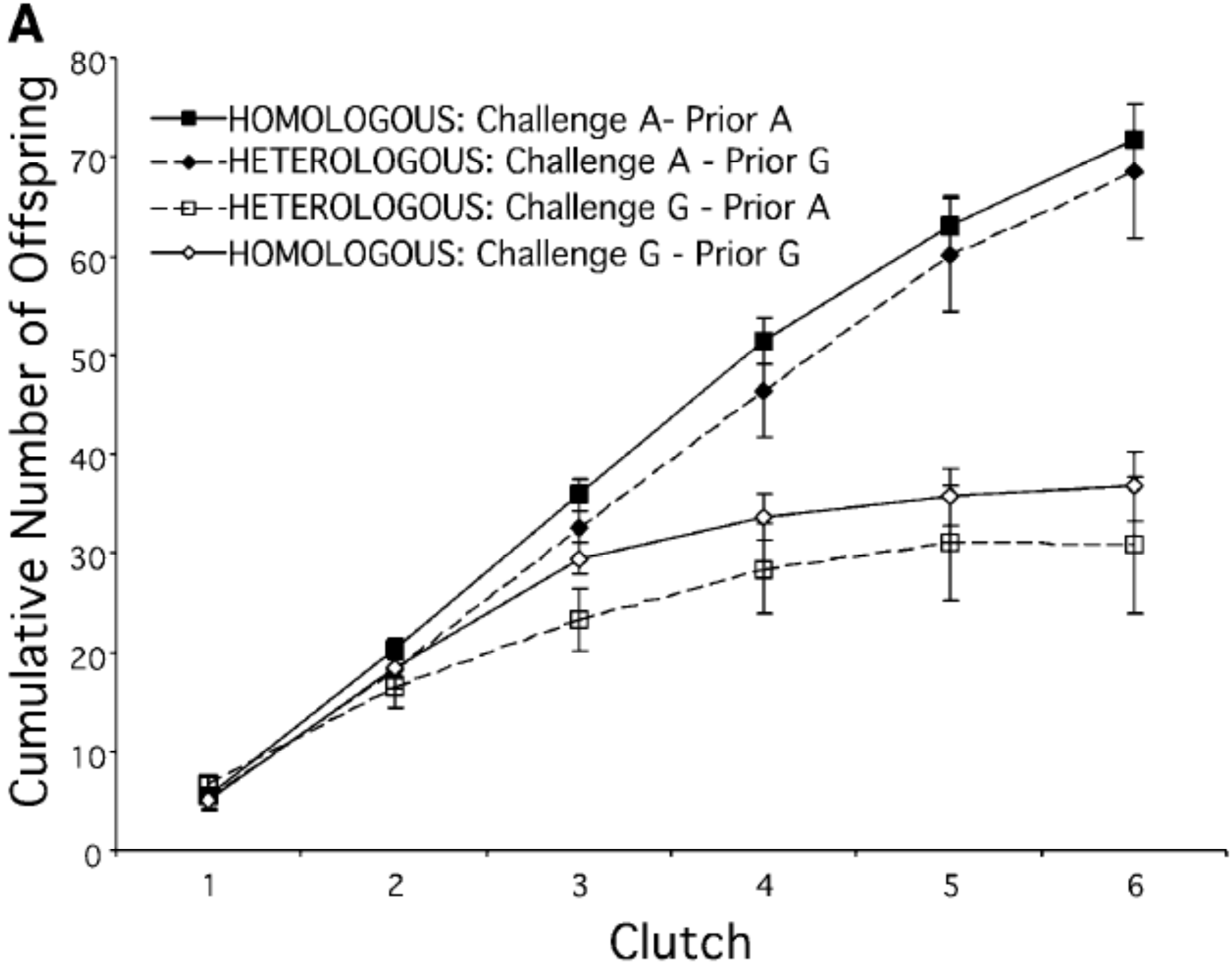




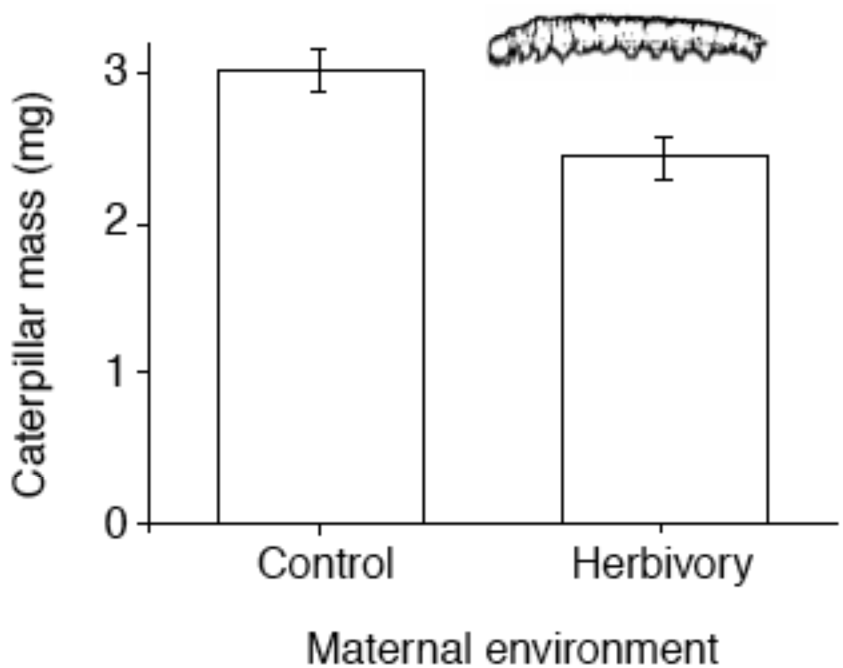
Agrawal et al 1999 Nature 401:60-63

Experimental protocol for Daphnia infection



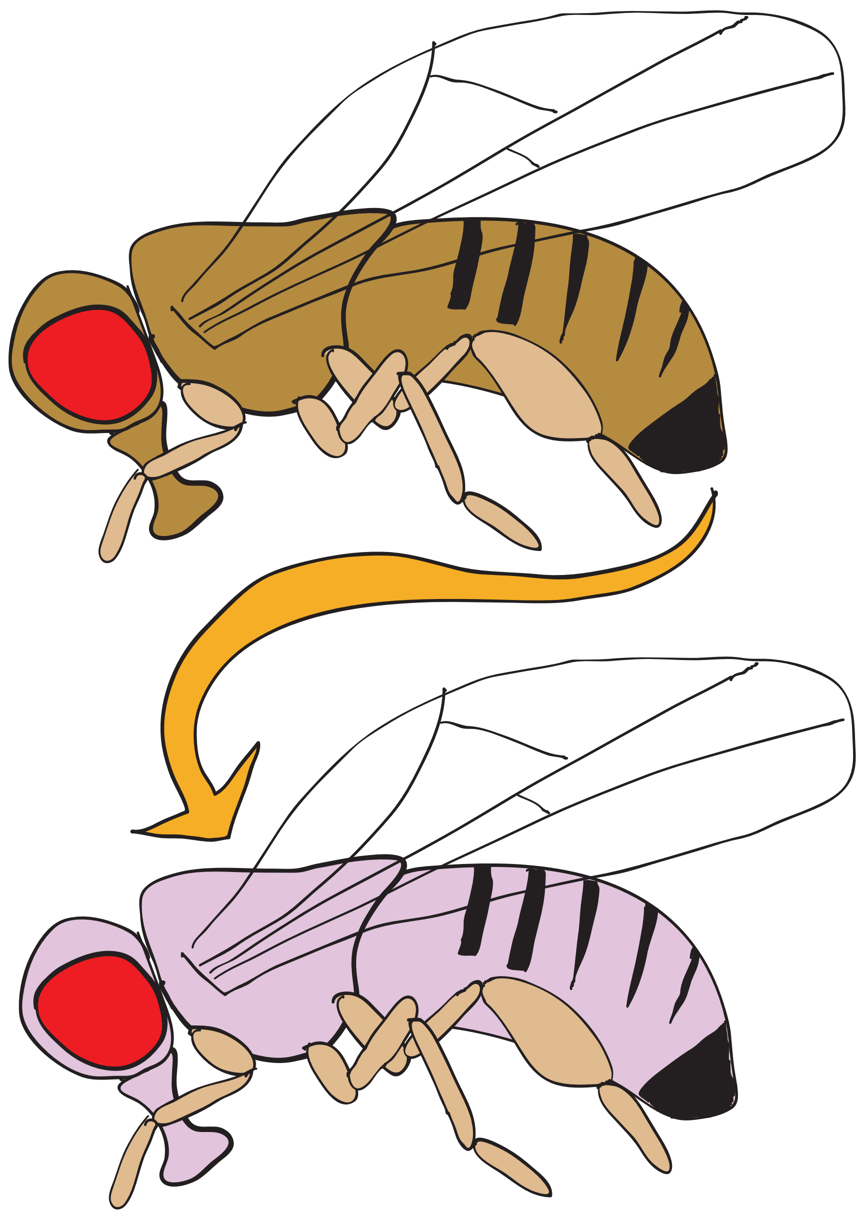

A
HOMOLOGOUS: Challenge A- Prior A
HETEROLOGOUS: Challenge A - Prior G
HETEROLOGOUS: Challenge G - Prior A
HOMOLOGOUS: Challenge G - Prior G
Cumulative Number of Offspring
Clutch
0
10
20
30
40
50
60
70
80
1
2
3
4
5
6

Raddish have a maternal regulated immune response

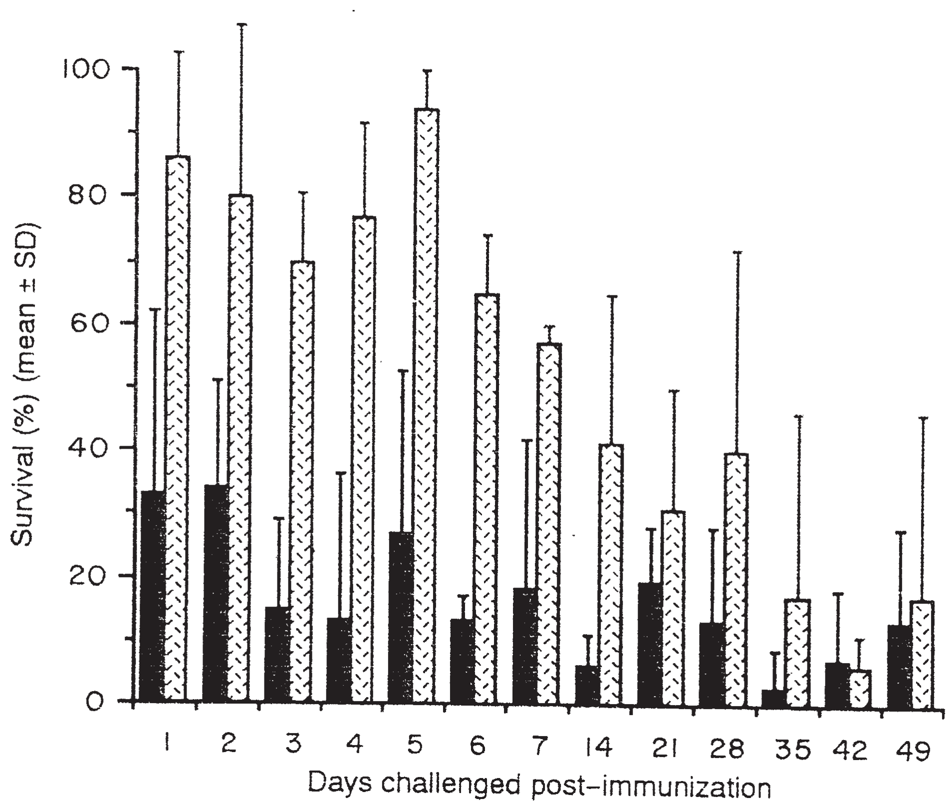


Agrawal et al 1999 Nature 401:60-63

Clearly there are many examples of maternal transmission of immunity



Cockroach immunity

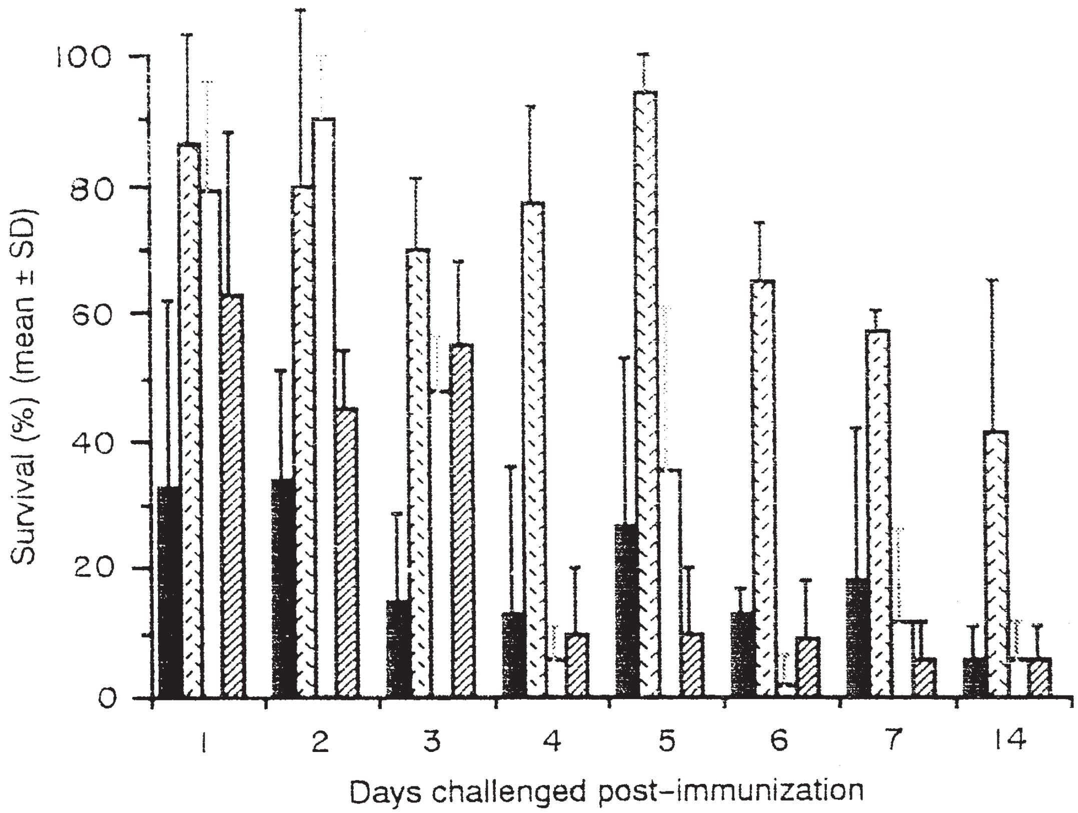


■ **unchallenged**

□ **previously challenged**

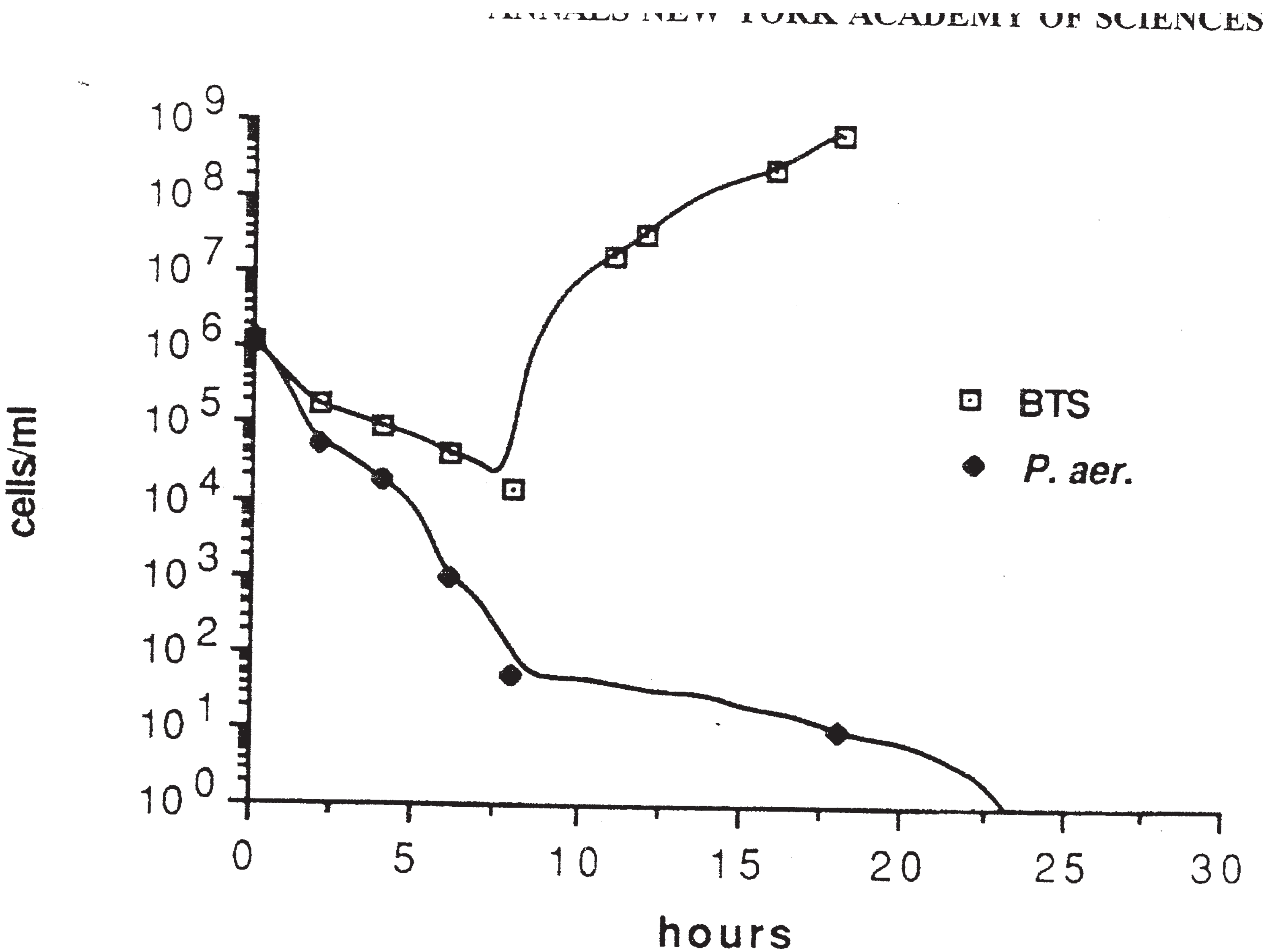
Faulhaber and Karp, 1992, Immunology, 5: 378-81

Prechallenge with gram positive bacteria does not offer long term protection agains Pseudomonas aeruginosa



Faulhaber and Karp, 1992, Immunology, 5: 378-81

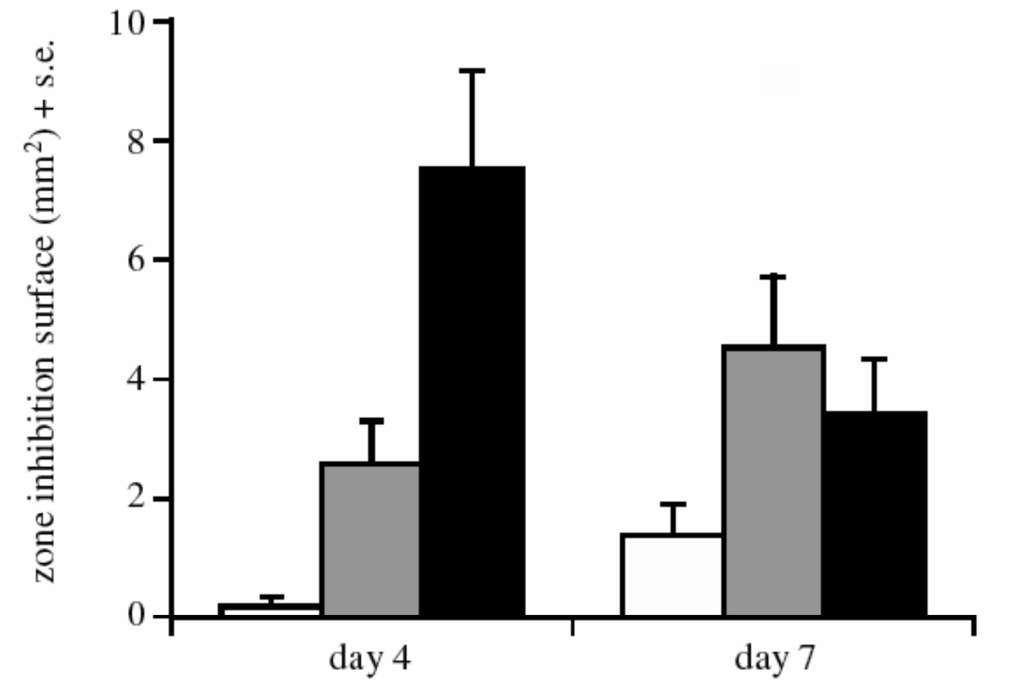
Does the roach experiment show a decaying immune response or an adaptation?



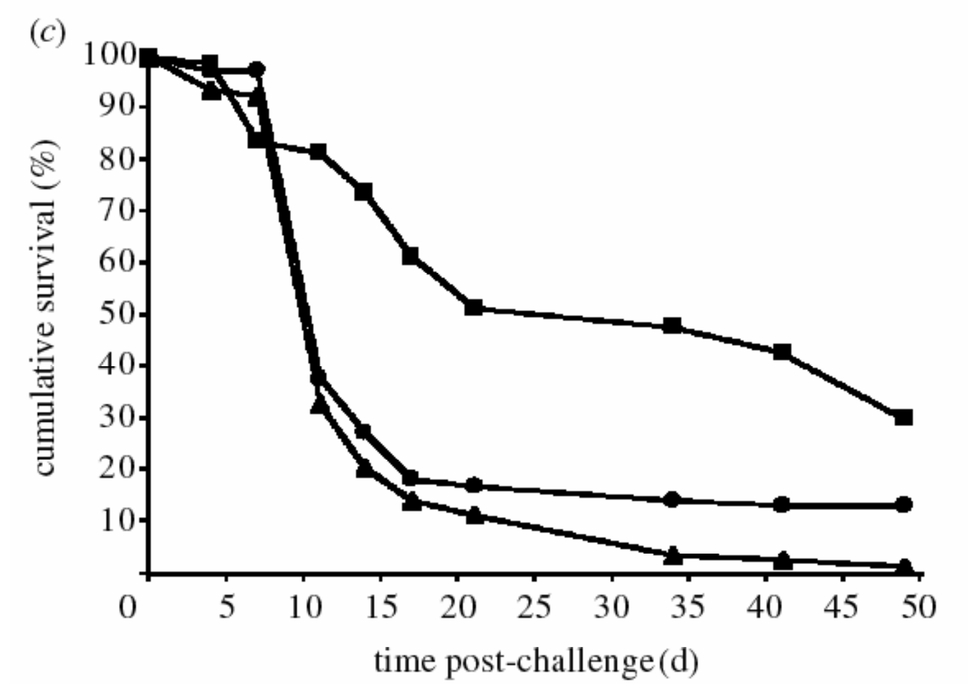
karp et al. 1994 Ann. N.Y. Acad. Sci. 712: 82-91

An insect immune response protects the animal for at least a week following infection

Zone of inhibition

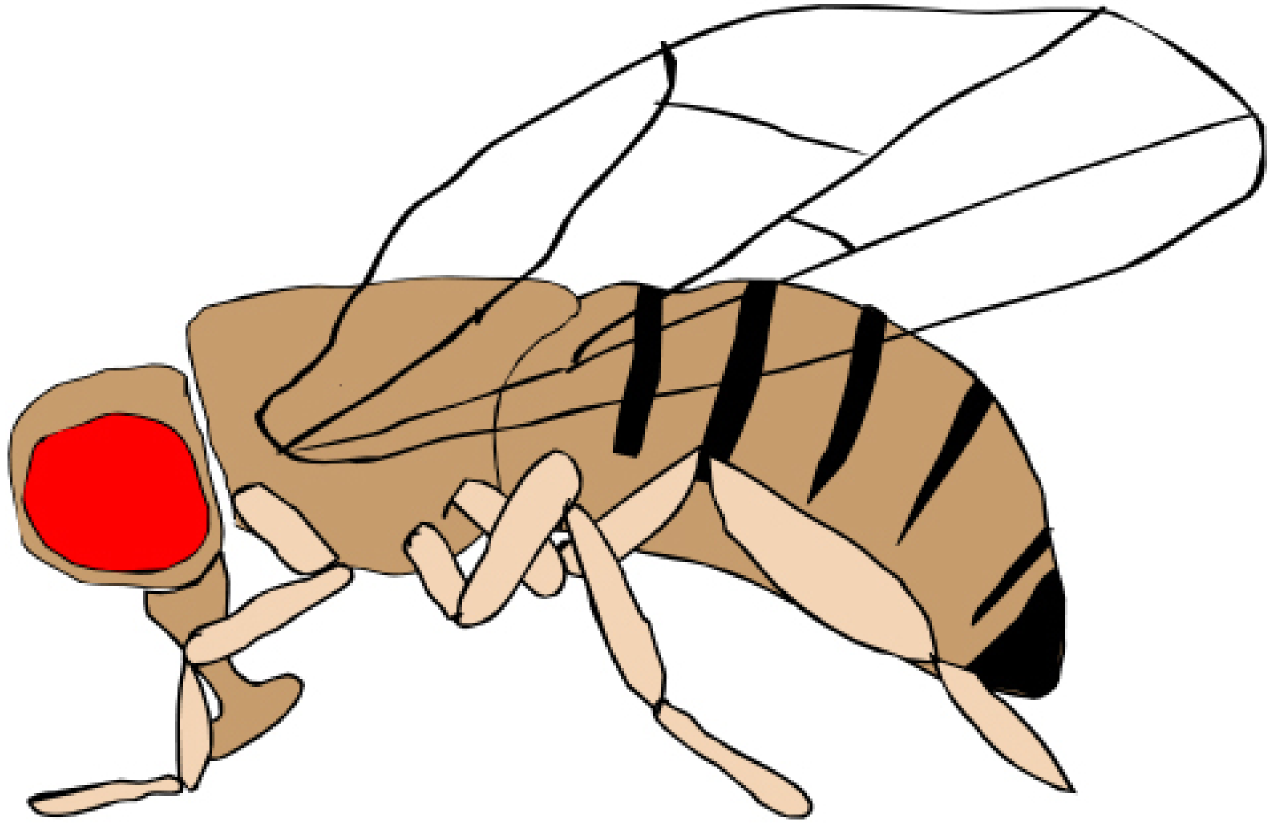


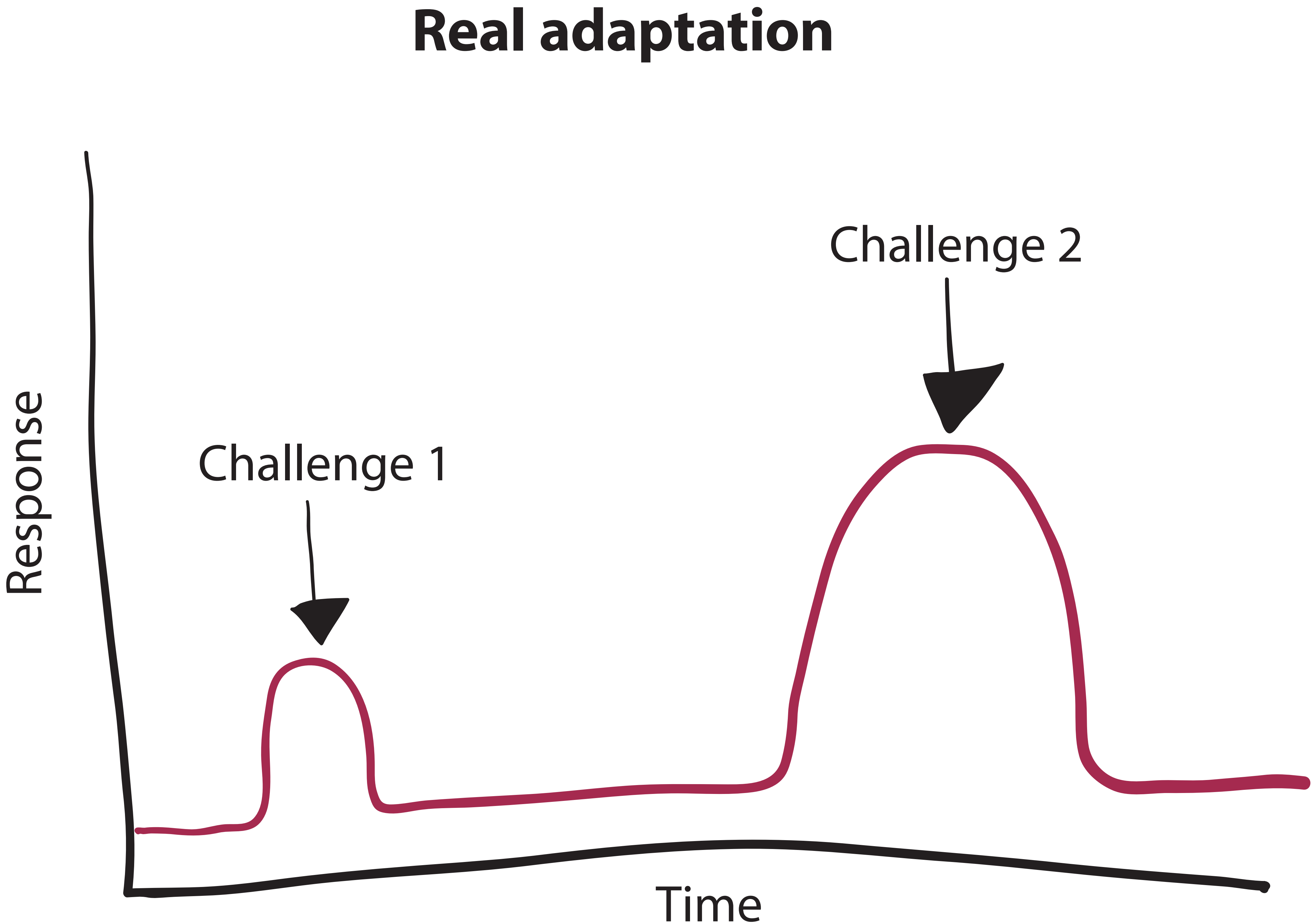
Survival assay



Moret and Siva-Jothy 2003 Proc. R. Soc. Lond. B 270: 2475-2480

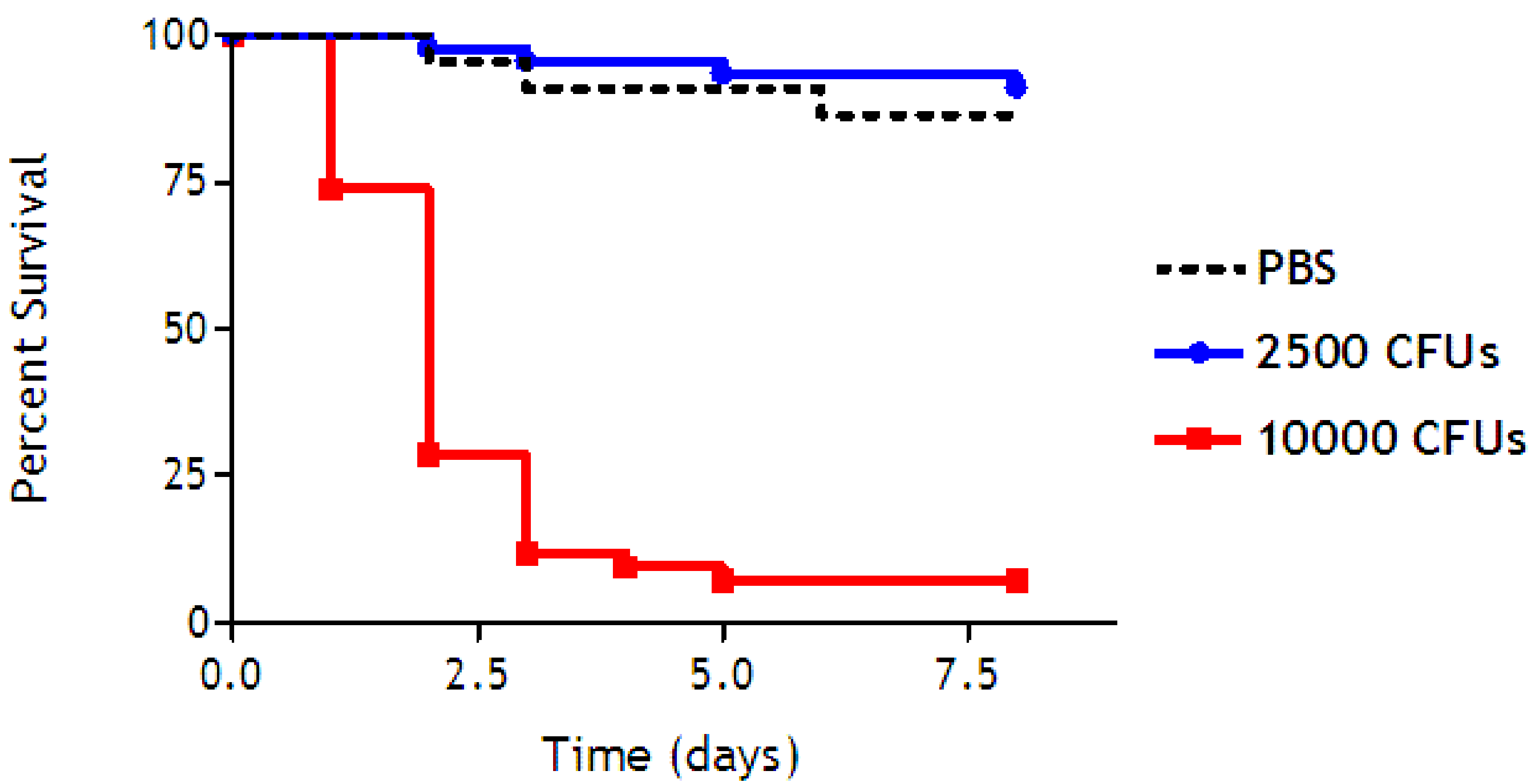
A long lasting immune response might be considered adaptive



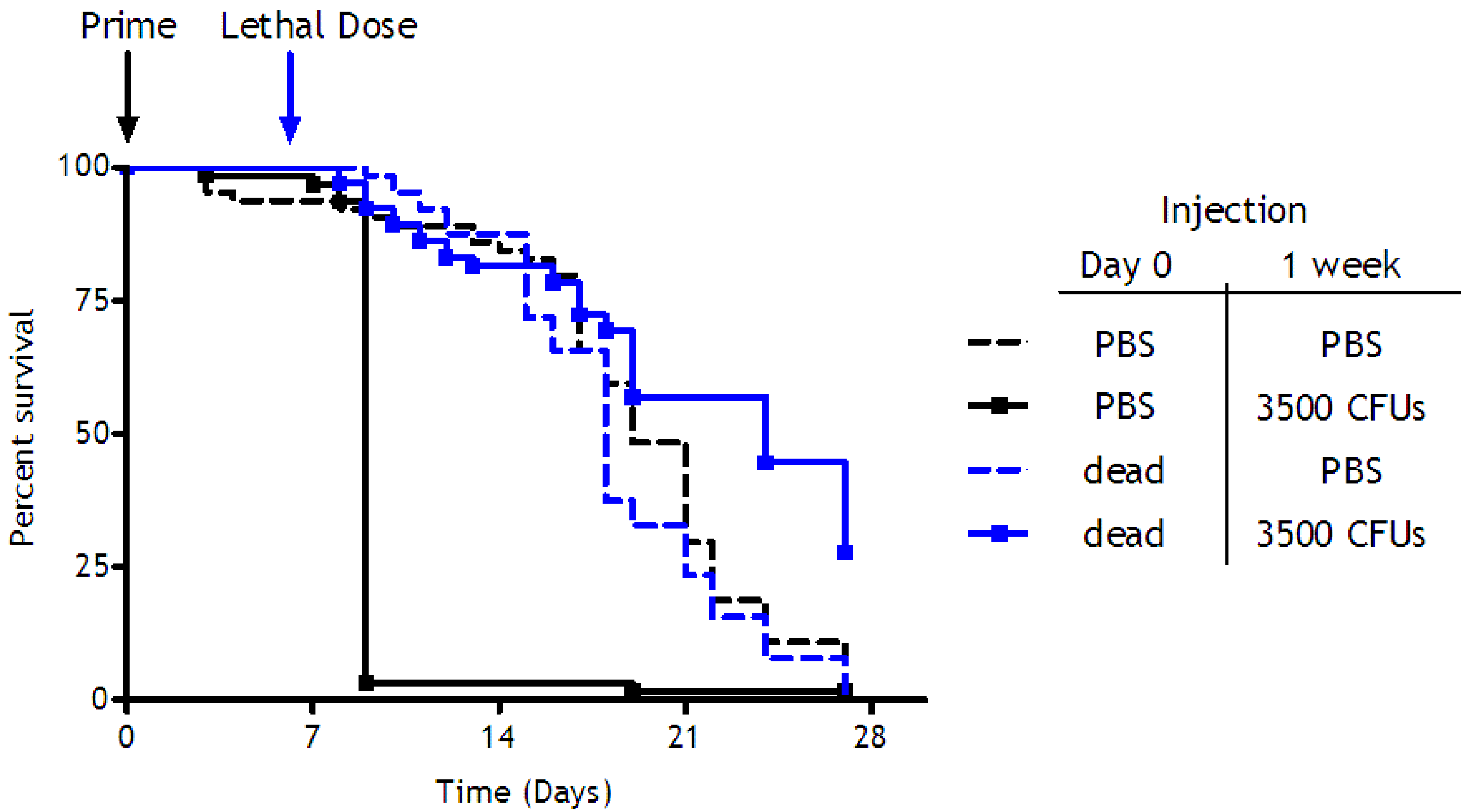


Real adaptation
Challenge 1
Challenge 2
Response
Time

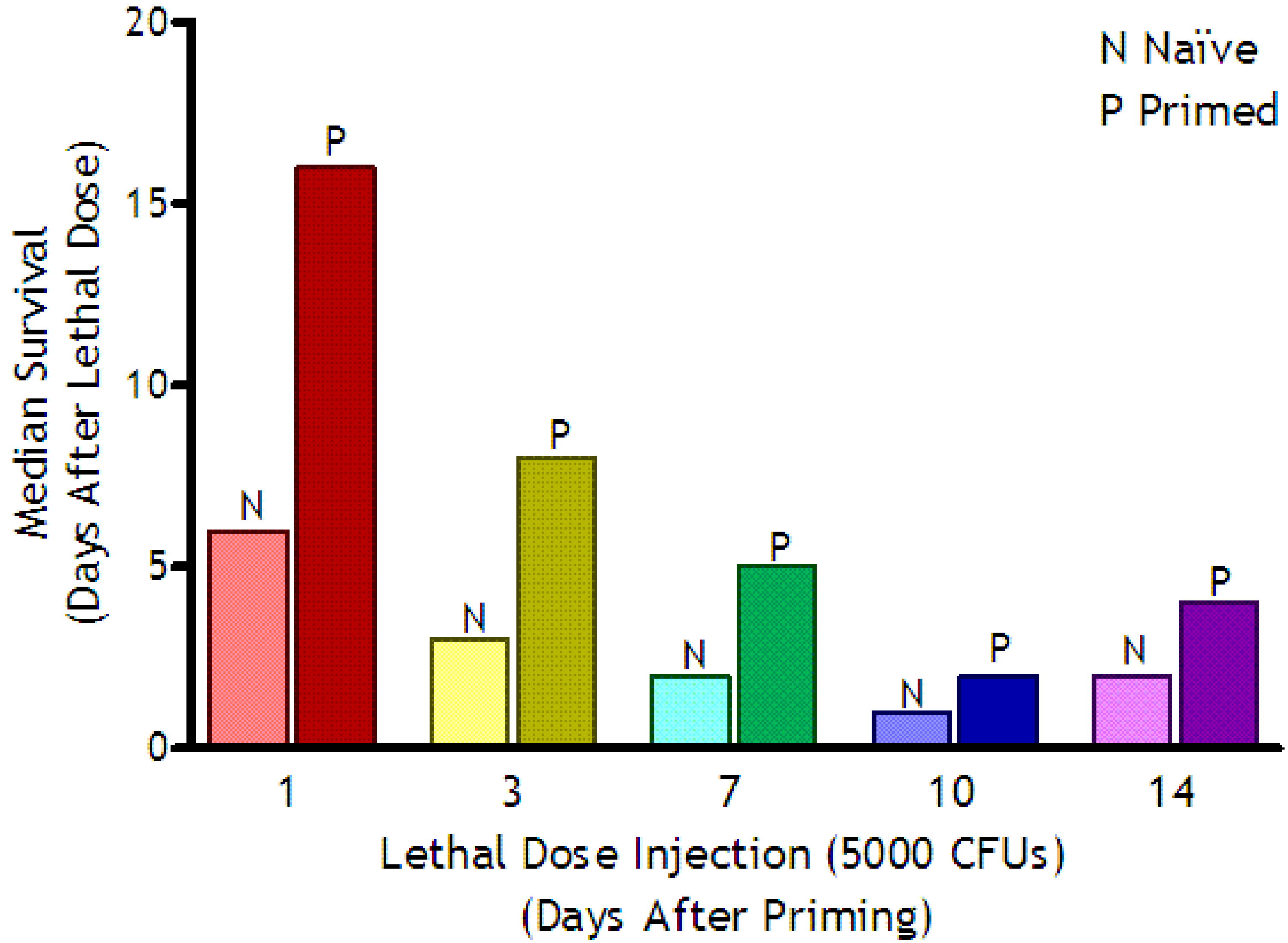
Streptococcus pneumoniae has a sublethal infectious dose in the fly



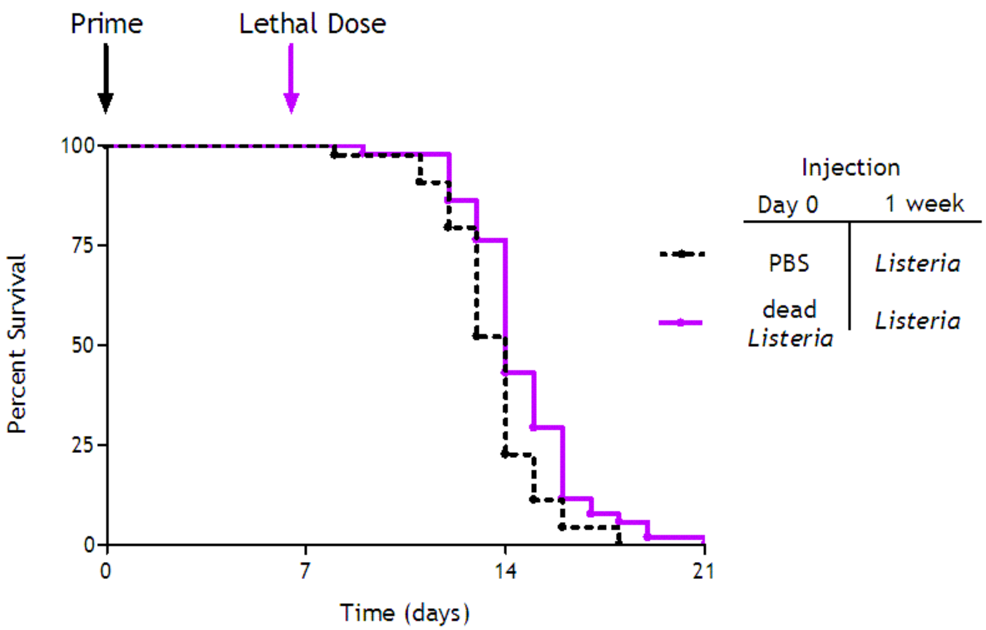
Dead S.pneumoniae can protect against live infections

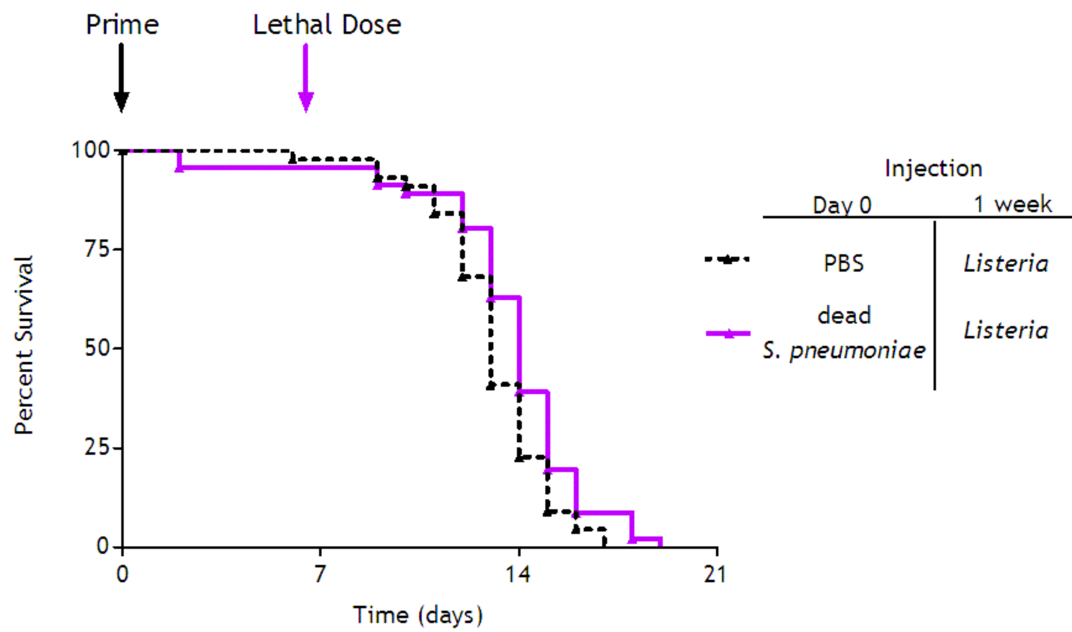


Priming lasts for as long as we can test it



Adaptation does not appear to offer cross protection

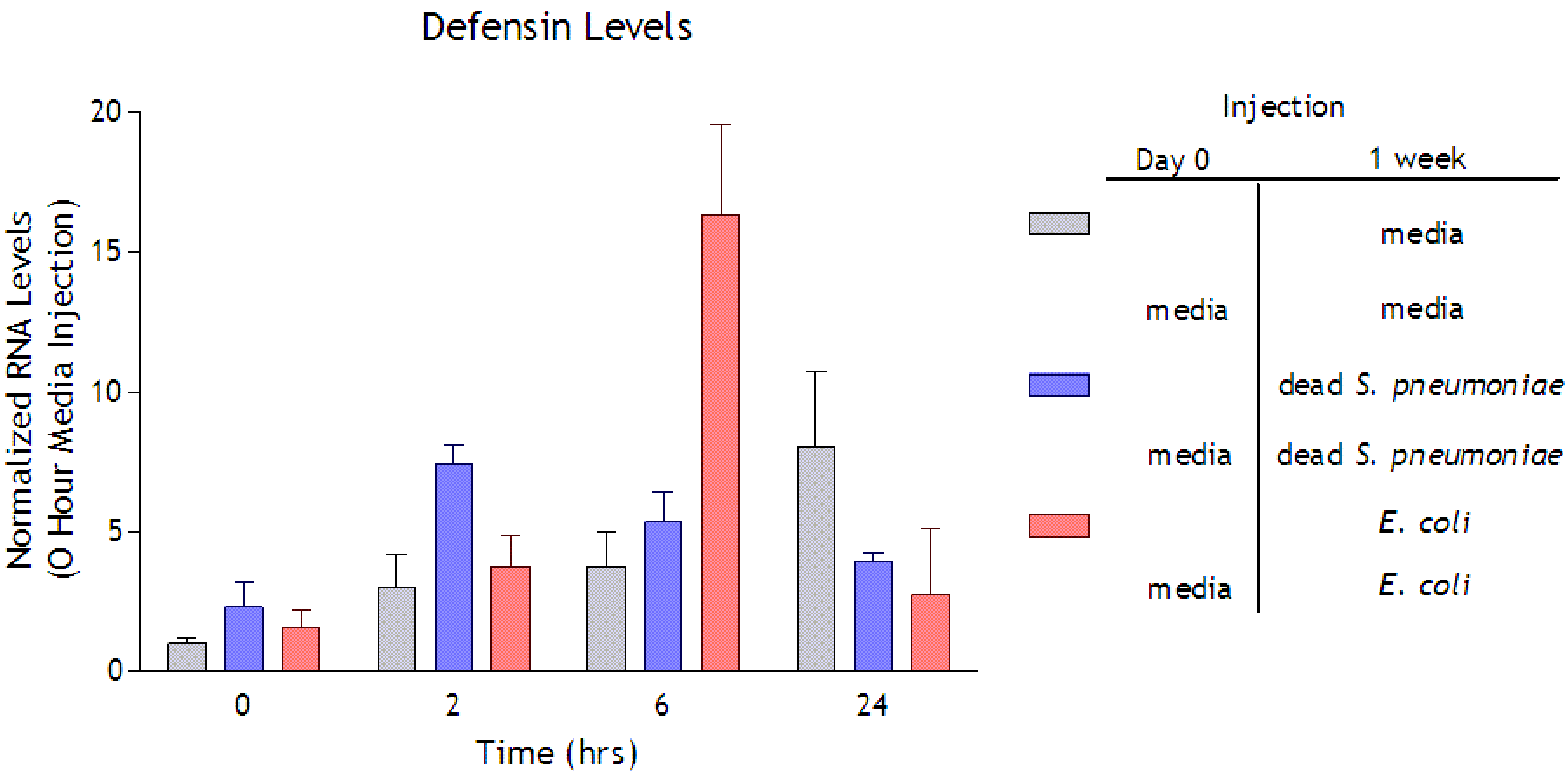




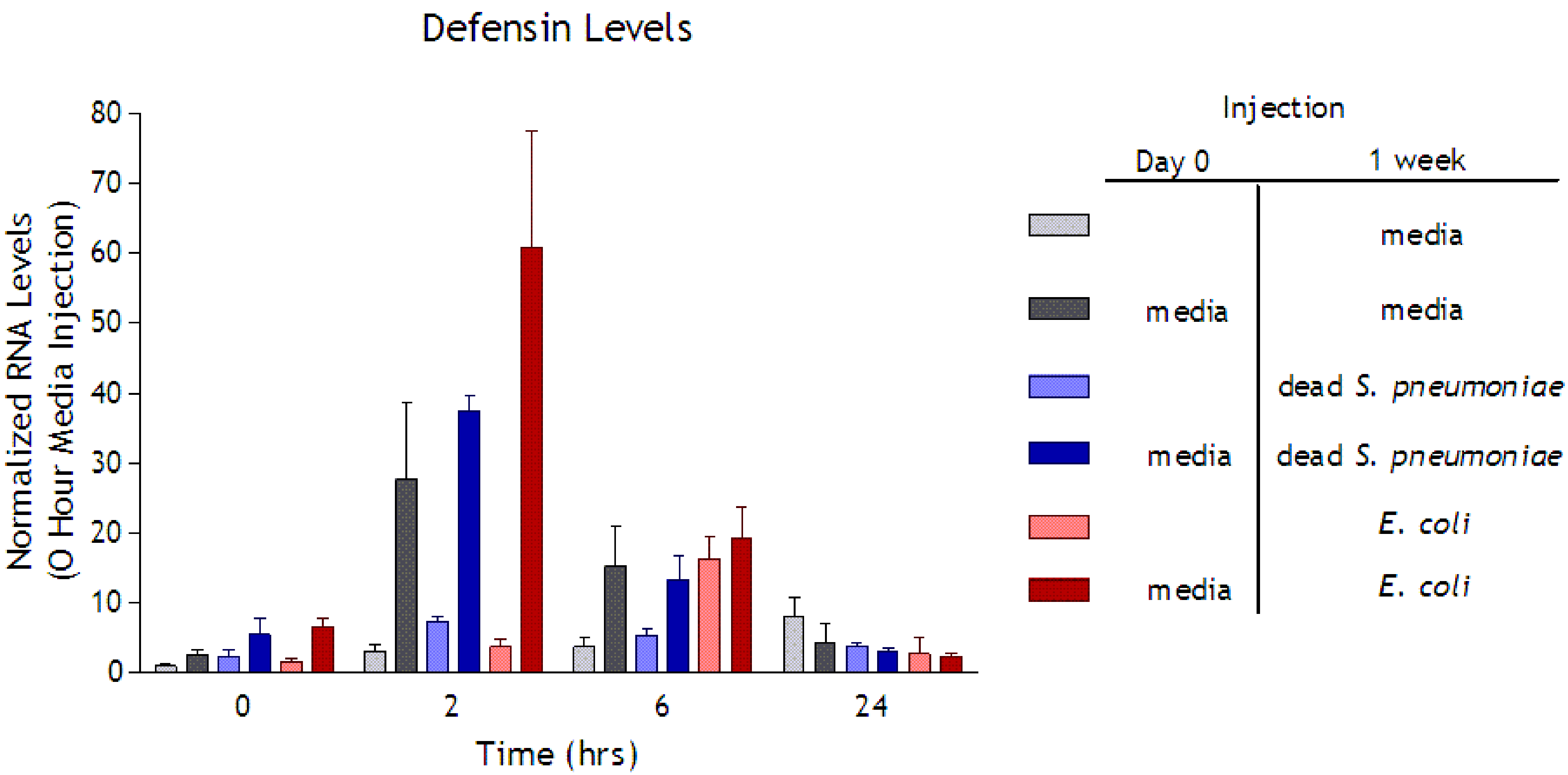
Prime: Listeria
Challenge: Listeria

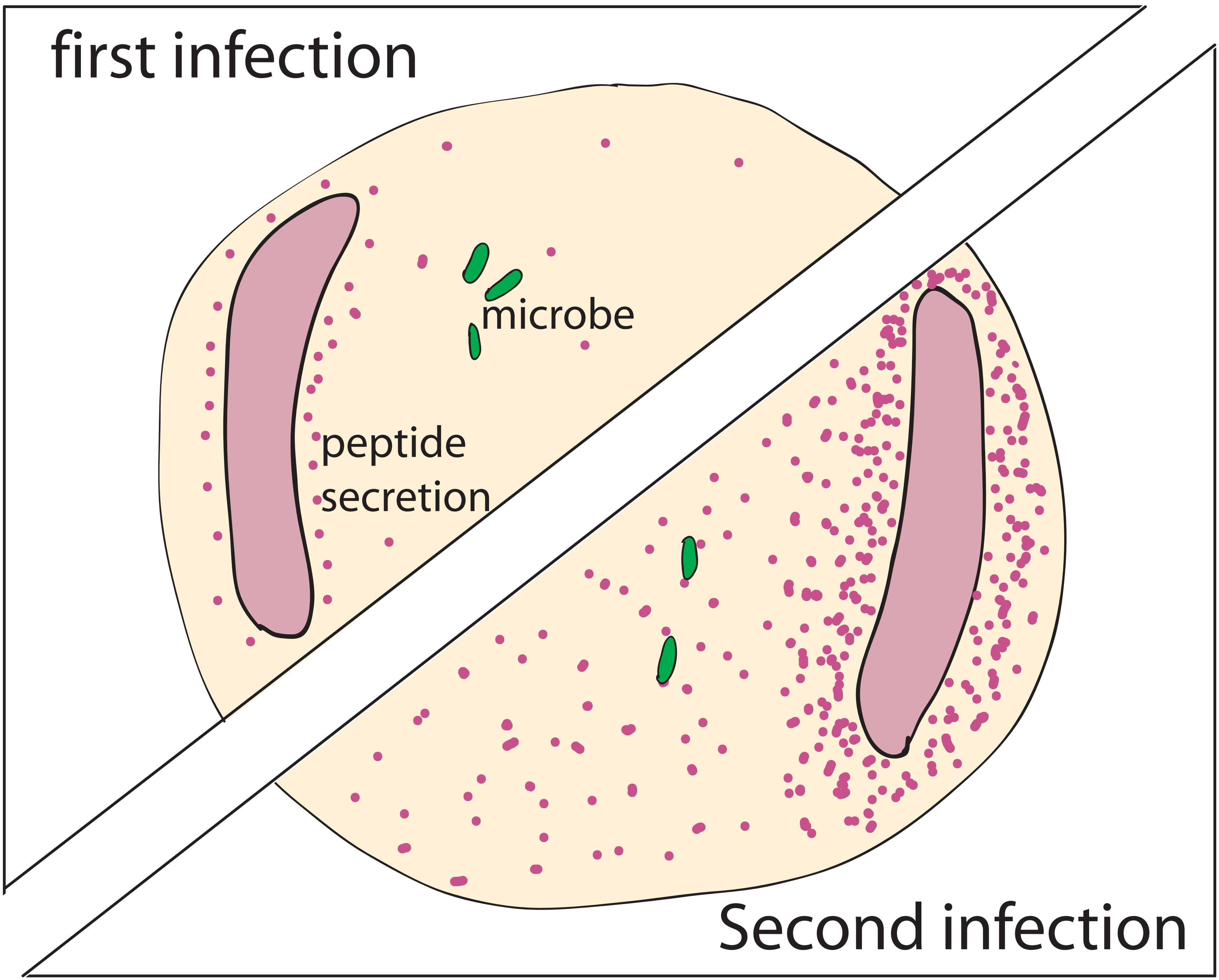
Prime: S.pneumoniae
Challenge: Listeria

During the first immune challenge antimicrobial peptide gene induction peaks at 6 hours



Primed flies respond faster and stronger




first infection
microbe
peptide
secretion
Second infection