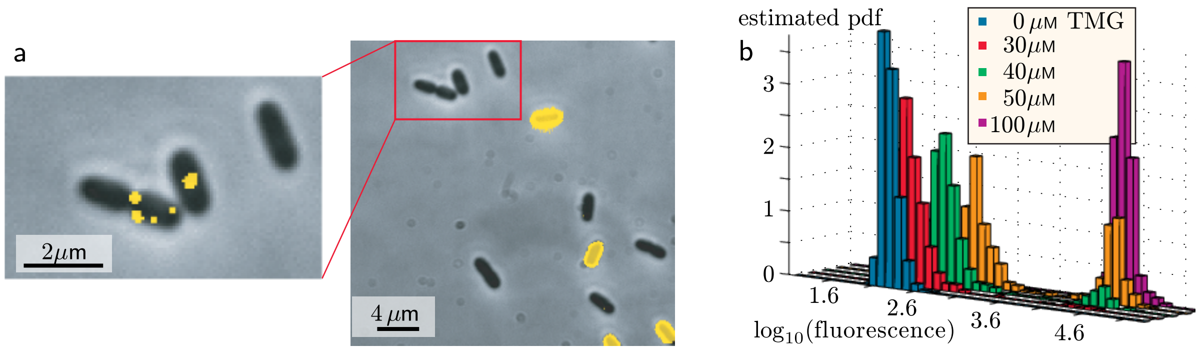

Figure 12.22: **Induction in the *lac* system.** (a) [Micrographs.] A strain of *E. coli* expressing a fusion of permease (LacY) and yellow fluorescent protein. *Right:* There is a clear distinction between induced and uninduced cells. *Inset:* Uninduced cells nevertheless contain a few copies of the permease. (b) [Experimental data.] Measuring the fluorescence from many cells confirms that the population is bimodal at intermediate inducer concentration (in this case, 40–50 μM TMG).
[(a) Adapted from Fig 1B page 443 of Choi, P J, Cai, L, Frieda, K, and Xie, X S (2008). A stochastic single-molecule event triggers phenotype switching of a bacterial cell. Science (New York, N.Y.), **322**(5900), 442–446. Reprinted with permission from AAAS. See also Media 14. (b) Data courtesy Paul Choi.]

was that, in this situation, initially uninduced cells have fixed probability per unit time of making a transition to the induced state.[31] Section 12.4.4 showed that this hypothesis could explain the data on induction at inducer levels slightly above the maintenance regime, but at the time there was no known molecular mechanism on which to base it. Novick and Weiner speculated that the synthesis of a single permease molecule could be the event triggering induction, but Figure 12.22a shows that this is not the case. Instead, P. Choi and coauthors found that permease transcription displays two different kinds of bursting activity:

- Small bursts, creating a few permeases, maintain the baseline level but do not trigger induction.
- Rarer large bursts, creating hundreds of permeases, can push the cell's control network past its separatrix and into the induced state, if the external inducer level is sufficiently high (Figure 12.22b).

T2 *Section 12.7.1′ (page 375) discusses the distinction between the large and small bursts just mentioned.*

Logical cells

Like all of us, *E. coli* prefers some foods to others; for example, Section 12.4.3 mentioned that it will not fully activate the *lac* operon if glucose is available, even when lactose is present. (It would be pointless to split lactose into glucose, if glucose itself is available.) Thus, remarkably, *E. coli* can compute a *logic operation*:

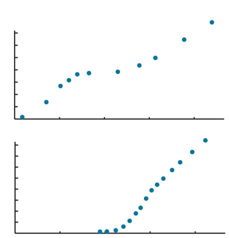

Fig. 12.9b,c, p. 345

Turn on the operon when (lactose is present) ***and*** *(glucose is absent).* (12.18)

Such a control scheme was already implicit when we examined diauxic growth (Figures 12.9b,c), because lactose was available to the cells throughout the experiment.

[31] See Idea 12.10 (page 346).