Physics of Solar Energy Conversion in Halobacteria by Photoinduced Proton Pumping

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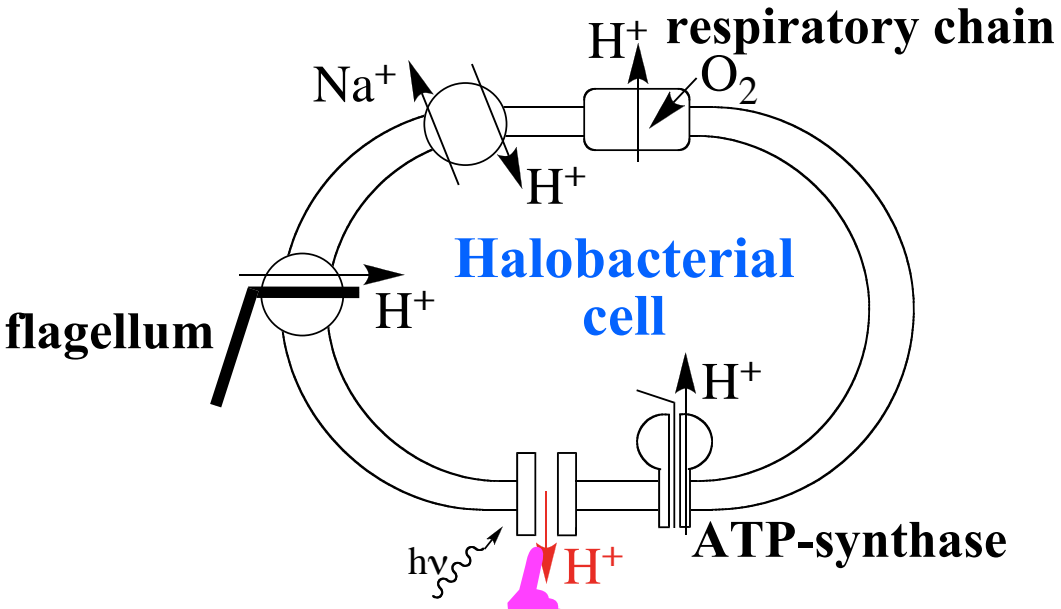


Light-driven proton pumping from inside to outside of cell

Photoinduced translocation of H^+ from cytoplasmatic channel with pH > 10 to extracellular channel with pH < 3.5

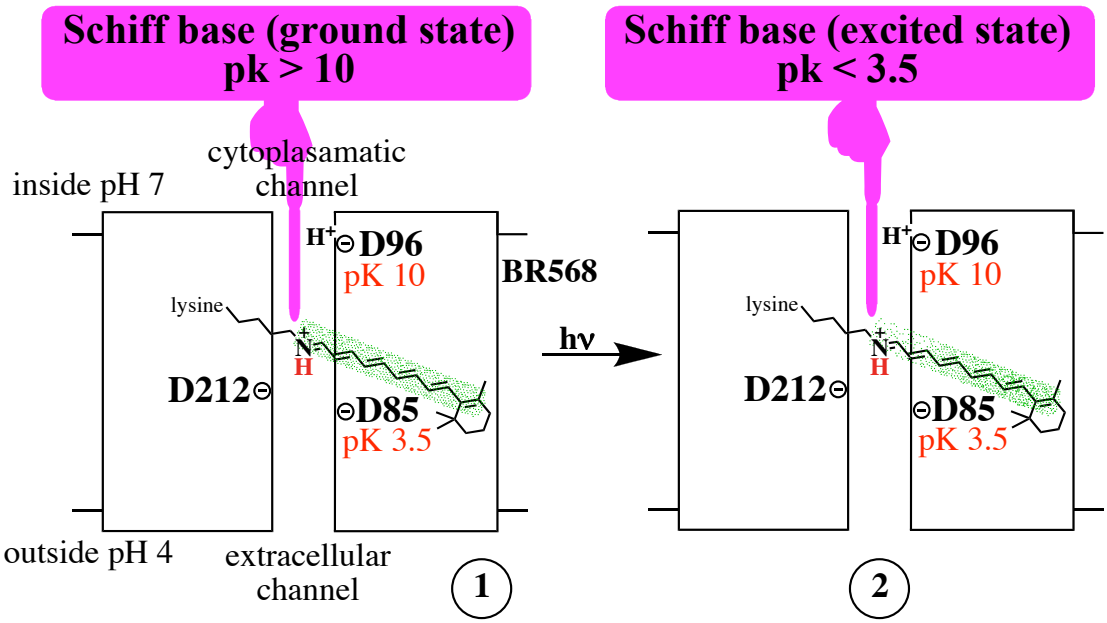
How can this happen?

Traditional model:

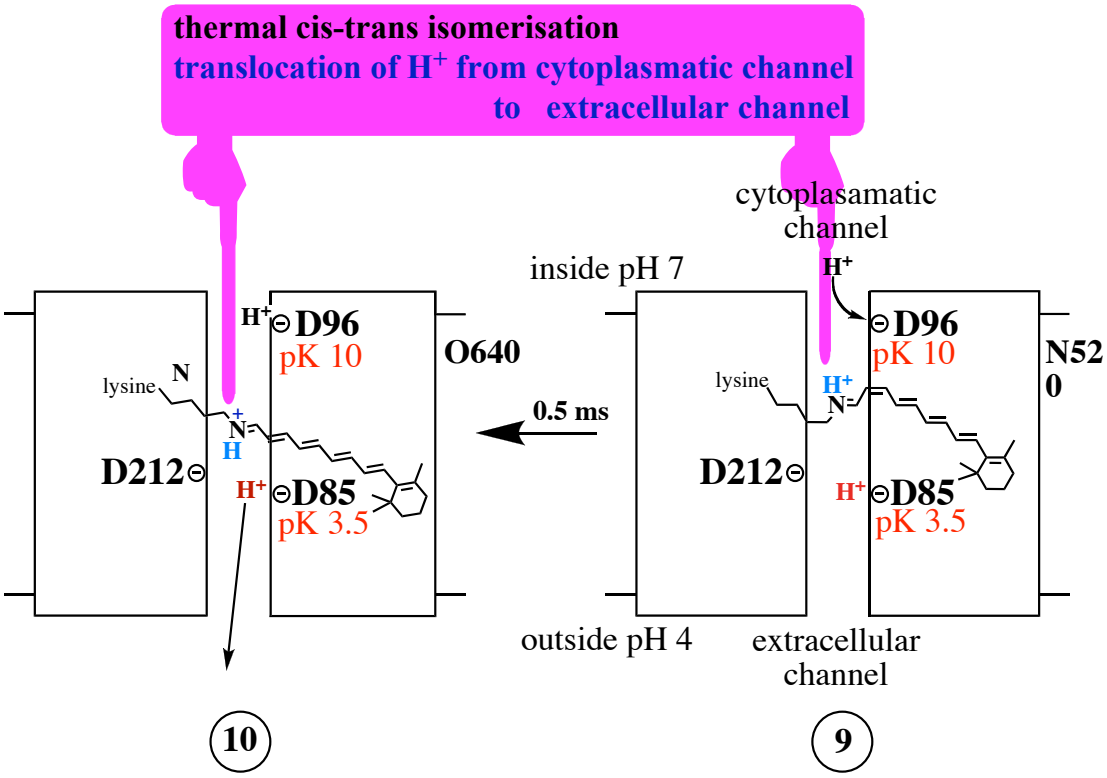
- translocation of H^+ from cytoplamatic channel to extracellular channel by conformational change of protein corresponding to step from 7 (stage L550) to 8 (stage M412)

Present model:

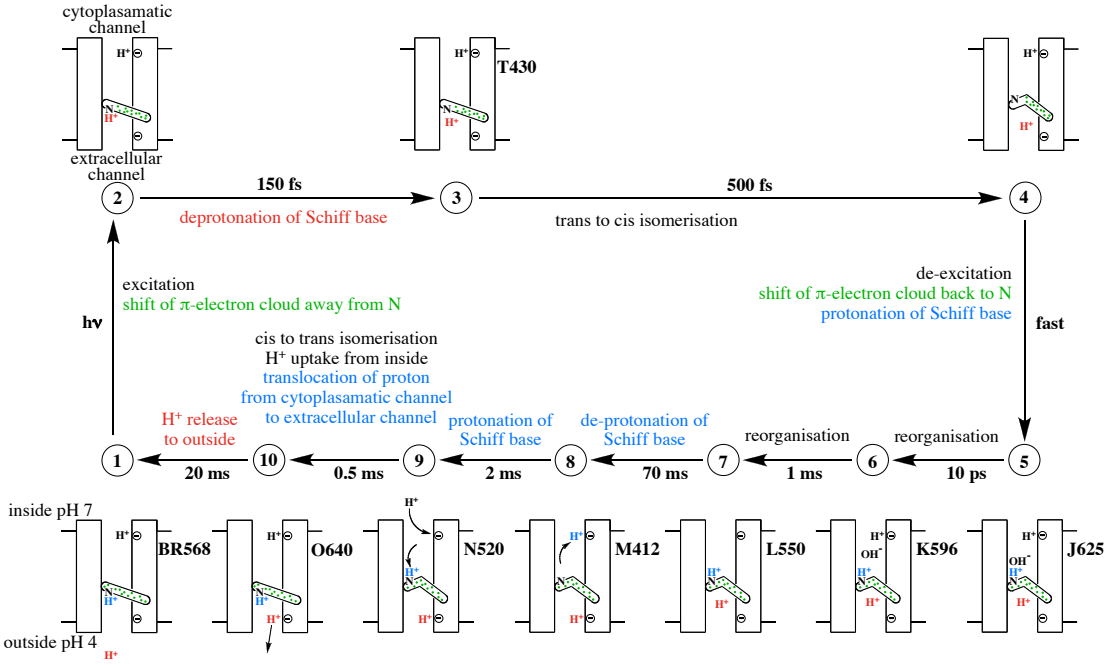
- initial steps from 1 to 3: photoinduced π-electron shift away from N and thus deprotonation of Schiff base leaving H^+ in extracellular channel
- translocation of H^+ from cytoplamatic channel to extracellular channel by thermal cis-trans isomerisation (step from 9 to 10)



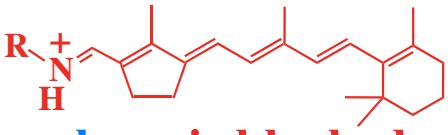
Coulomb field ($4 \cdot 10^9$ V/m, from D212 and D85)
shifting π-electron cloud away from N:
bonding of NH^+ weakened by 0.5 eV → ΔpK = -8.3 (exp: 3.5 - 10 = - 6.5)

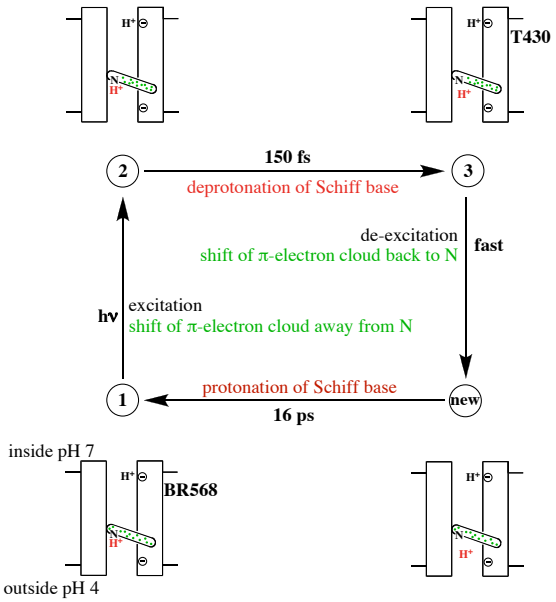


Presented model: Synopsis



Present model supported by mutant in which trans-form of chomophore is blocked:





- photoinduced release of H^+ into extracellular channel as in wild-type
- recombination slow (16ps)

Traditional model:

- **U. Haupts, J. Tittor, D. Oesterhelt**
  Biochemistry 36, 2 (1997)

Present model:

- **H. Kuhn, C. Kuhn**
  Chem. Phys. Lett. 253, 61 (1996)
- **H.Kuhn, H.-D. Försterling, D. WaldeckPrinciples of Physical Chemistry**
  2nd Ed., Wiley 2008

Femto-second spectroscopy:

- **J. Dober, W. Zinth, W. Kaiser, D. Oesterhelt**
  Chem. Phys. Lett. 144, 215 (1988)
- **J. Herbst, K. Heyne, R. Diller**
  Science 217, 822 (2002)

Mutant with chromophore blocked in trans-form:

- **A. Aharoni, I. Weiner, M. Ottolenghi, M. Sheves**
  J. Biol. Chem. 275, 21010 (2000)